POWER PLANT ENGINEERING

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Isolated Plant for Foundry and Machine Shop

NEW FACTORY OF W. A. JONES FOUNDRY & MACHINE CO. HAS A SMALL BUT MODERN POWER PLANT WITH STANDARD EQUIPMENT THROUGHOUT

HAVING OUTGROWN ITS FORMER factory and anticipating future growth, the W. A. Jones Foundry & Machine Co. procured property at 44th Ave. and 12th St., in Chicago and has built thereon a modern factory consisting of foundry, machine shop, pattern shops and offices, for making power transmission machinery such as pulleys, gears, bearings, clutches, etc. In the hollow square formed by the factory buildings is located a modern, well-equipped power plant which serves the factory with light, heat power and fire protection.

Being a detached building, the power plant is provided with large windows on three sides, which make the plant cheery with natural light. The separate building plan also gives freedom in arrangement of machinery so that this is the ideal of the designer for the size and purposes of the plant. A switch track from the Chicago Belt Line runs along the west end of the plant, and coal is received and ashes carried away on this track.

From the cars, coal is shoveled into a bin of 400 tons capacity extending the width of the building directly in front of the boilers. From the bin a gang plank leads to the stoker hoppers to which the coal is carried in wheelbarrows.

Steam generating equipment consists of three 207-hp. Kroeschell combination water-tube and fire-tube boilers.

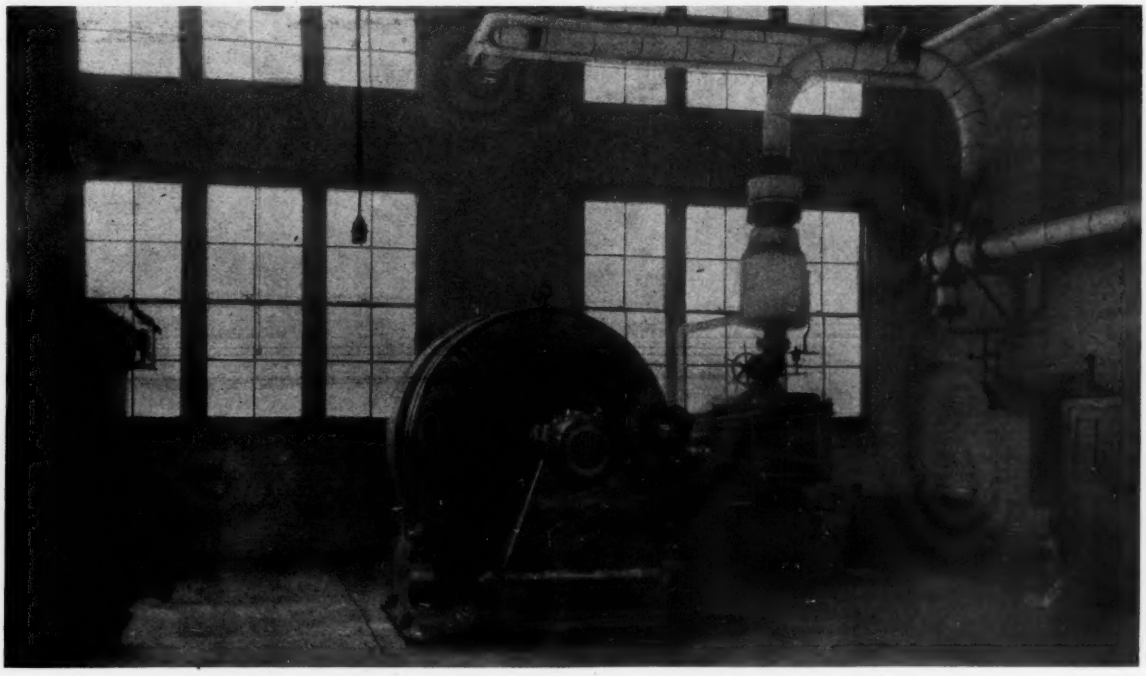


FIG. 1. GENERATING UNIT IN THE JONES PLANT

The shells are 68 in. in diameter by 17 ft., 6 in. in length and contain 68 fire tubes 4 in. in diameter; there are 29 water-tubes 3½ in. in diameter. The boilers are worked at 150 lb. pressure.

Provision is made in the plant for one more boiler of the same size, all four boilers being in one setting with a passageway along the north wall of the plant. Two

of the boilers are at present equipped with Model stokers which have dutch oven type furnaces and gravity side feed grates. The other boiler, which is used as a standby, has a shaking grate and the furnace is equipped with a device for admitting jets of steam and air over the fire for a short time after firing to burn off the volatile gases and prevent smoke. Ashes are handled by an American Steam Conveyor. At present these are used about the factory for filling, but when not needed here, they will be discharged into a hopper which will empty by gravity into railway cars for disposal.

Wright improved safety water columns with high and low water alarms are mounted on the boilers with blowoff pipes leading to the ash pits. The boilers are also equipped with Bayer soot blowers which have jets at the rear of the boilers for blowing off the water tubes and at the front for cleaning the fire tubes. The soot

son open heater from the city water mains. The temperature as it enters the boilers is from 200 to 212 deg. F. Three boiler feed pumps are provided, two of these are Burnham simplex 6⅛ by 4 by 8 in., the other is a Camden duplex pump 6 by 4 by 6 in. These are so piped that they can deliver to the boiler either cold water from the mains or hot water from the heater.

Separate feed water lines lead from the pumps to each of the boilers. At the boiler, the pipe branches and two pipes enter the rear end of the boiler shell. These are perforated inside the boiler and extend two-thirds the length of the boiler.

From each boiler, two 1½-in. blowoff pipes lead from the rear water leg to a blowoff header which discharges into a steel tank 36 in. by 12 ft., then to a cooling basin and to the sewer. In each blowoff pipe from the boiler are two valves, one a Crosby, the other a Simplex.

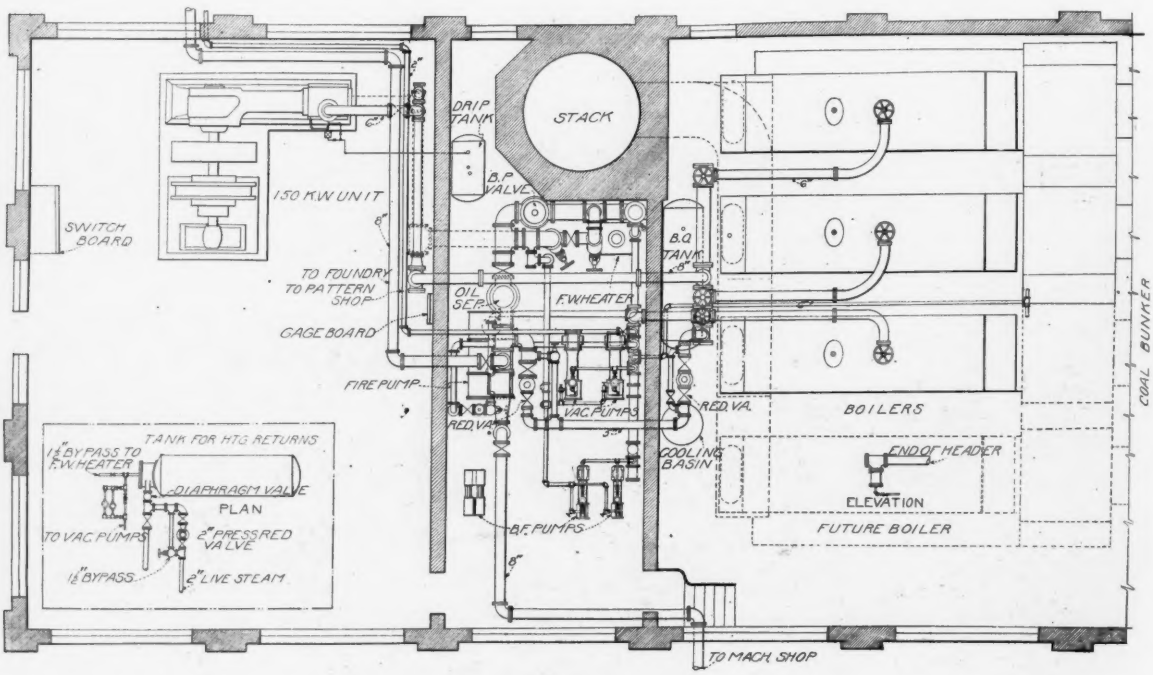


FIG. 2. GENERAL PLAN OF PLANT AND PIPING

is, therefore, blown in the direction the flue gases naturally take, and excellent results are secured when the blowers are used every 6 hr.

Mounted on each boiler shell are two Crosby 3-in. pop safety valves in the twin arrangement and for giving warning against low water, besides the water column whistle, a fusible plug is attached to the shell 2 in. above the fire tubes.

Flue gases are led by a common breeching to a brick stack 6 ft. in diameter by 150 ft. high. Draft in the common breeching is controlled by a Spencer damper regulator, but for individual boilers separate hand-operated dampers are provided giving a means for distributing the load among the boilers as requirements direct.

Boiler feed water is largely the returns from the heating system during the winter months with makeup water drawn through a float operated valve in the Cook-

Steam piping is arranged on the back to back plan, with the main 10-in. header in the boiler room. This is fed by 6-in. leads from the boilers which take the form of long radius horizontal bends; at the boiler are Foster auto-stop and check valves, while at the header Lunkenheimer globe angle valves are used.

A 6-in. line connects the main header to the engine room header; a 5-in. line carries live steam to the heating system through two Boylston reducing valves in series, which reduce the pressure in steps from 150 to 1½ lb.; another lead from the main header delivers steam to the pump room header. All heads are provided with drip pockets which discharge condensate through Boylston traps to the feed water heater.

In the Engine Room

THE PRESENT electric generating equipment is a single unit, but provision is made for another of larger

size which will be installed when power requirements demand. This is a Ridgway dynamo and engine unit of 150 kw. capacity. The engine is of the four-valve non-releasing gear type, with a cylinder 16 by 18 in. and runs at 200 r.p.m. The generator is of the direct current three-wire type delivering current at 250-125 v.

A two panel switchboard has mounted upon it two ammeters, a voltmeter, a four-pole switch, two circuit breakers, a recording voltmeter, a watthour meter, two three-pole switches, and two three-pole switches for the plant lights. On the engine room gage board are four instruments to indicate the steam pressures on the header, boilers Nos. 1 and 2, and on the heating system, two recording gages give boiler steam pressure and pressure on heating system, a differential gage gives the draft in the furnace and the plant clock is mounted on this board.

In addition to this water supply for fire protection, a Fairbanks-Morse fire pump is provided which takes water from the city mains or the elevated tank. This pump is of the duplex type with dimensions 6 by 9 by 12 in.

This is not a large plant, but load conditions indicate the need of additional capacity in the near future, and beyond the addition of another generating unit, further extensions can be made without rearranging the general plan of the plant, by extending the width of the building.

THOSE WHO think German industries are paralyzed may be surprised to learn that the plant of the Allgemeine Elektricitats Gesellschaft has increased to 190 acres of floor space, the working force to 79,293 employes, the gross profits for 1916-17 to 46,793,247 marks, a gain of 8,930,000 marks over the profit of the previous year. Units of 50,000 kw. are being built, and transformers of 60,000 kv.a. for 110,000 v. The firm cannot keep up with its orders for high-voltage equipment.

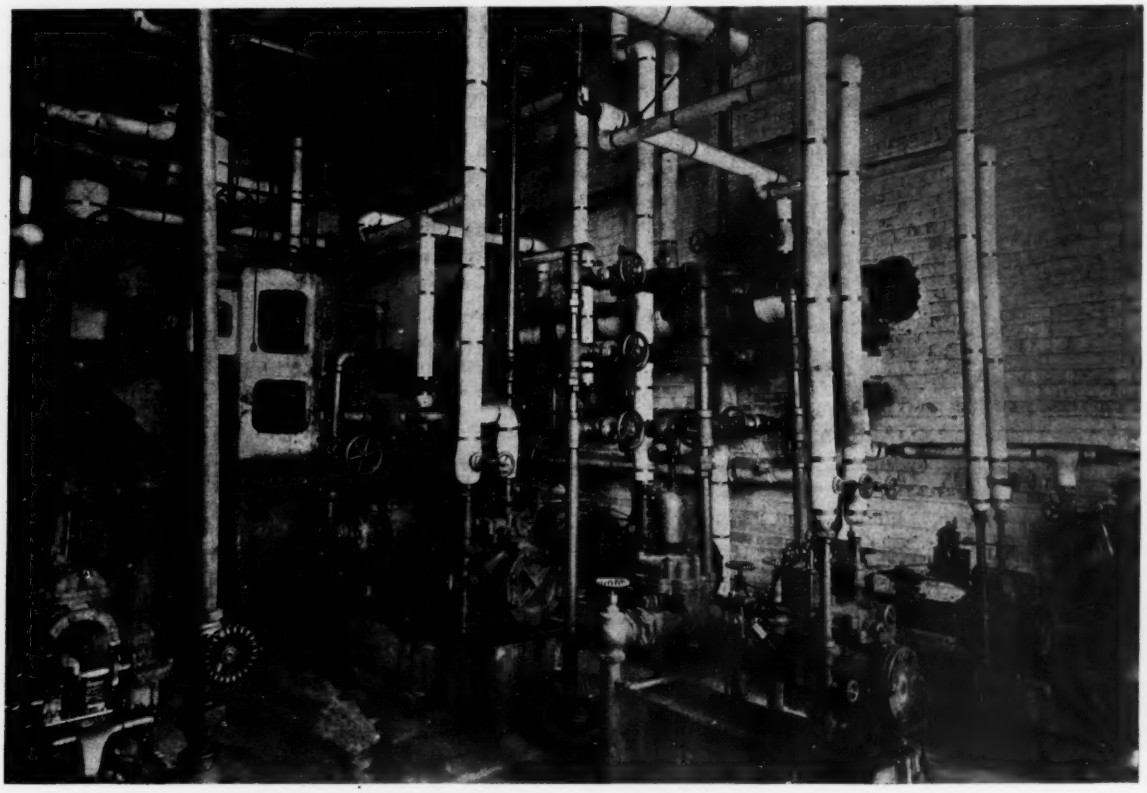


FIG. 3. VIEW SHOWING FEED WATER HEATER, VACUUM AND BOILER FEED PUMPS

Exhaust from the engine and pumps goes to the feedwater heater through an oil separator on the heater, being drawn in by induction. During the heating season, a Western Kieley back pressure valve is used to force the exhaust to the heating system through an oil separator.

Heating is accomplished by a Dunham vacuum system, the vacuum in which is maintained by two Burnham simplex pumps 10 by 12 by 12 in. equipped with Dunham pump governor. Besides heating the factory buildings, steam is supplied to prevent the freezing of the water in a 40,000-gal. tank mounted on a steel tower which supplies the sprinkler system at a pressure of 35 lb.

MANY PLANTS still follow the extravagant practice of burning their oily waste, but scarcity of fats and petroleum products has created wider interest in the reclamation of both waste and oil by extraction in centrifugals, filtering and refining the oil for further use, and drying the waste in ovens. The high price of cotton waste, as well as lubricating and cutting oils, makes reclamation profitable.

Power Plant Instruments as an Investment—V

Flue Gas Analysis Instruments and Draft Gages. By M. A. Saller

FLUE GAS analysis bears the same relation to the boiler room that the indicator does to the engine room—it furnishes a check or measure on vitally important factors which, while they cannot be observed with the naked eye, have considerable bearing on economy and efficient operation.

In a boiler plant equipped with modern boilers fired with no particular care or attention to fuel economy, the heat efficiency will usually run as low as 50 to 60 per cent. In contrast, the same plant will show an efficiency

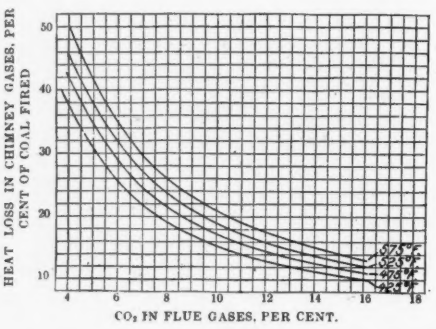


FIG. 1 RELATION BETWEEN PERCENTAGE OF CO_2 IN FLUE GASES AND THE HEAT LOST IN THE DRY CHIMNEY GASES

of 75 or 80 per cent if carefully and correctly fired, i. e., if the proper conditions as to firing, draft, air control, insulation, etc., are provided.

The matter of securing high furnace efficiency (which usually represents a clear gain of from 30 to 40 per cent over improper methods) resolves itself into the consumption of the combustible with the least amount of air, and flue gas analysis paves the way for ascertaining to what degree this desired condition is being approached.

Two of the greatest losses in the furnace are occasioned by the heat lost in excess air in the chimney gases (ordinarily amounting to as much as 20 to 30 per cent of the total heat value of the coal), and the loss due to incomplete combustion of the fuel (amounting to 5 or 10 per cent of the total coal bill). Flue gas analysis offers a check against both of these serious losses, and therefore points out opportunities for savings sufficient to pay for the cost of the apparatus many times over in the course of a year's operation.

Excess Air Losses

For the complete combustion of one pound of coal in the ordinary boiler furnace about 15 lb. of air should be necessary, this air being taken into the furnace at atmospheric temperature and leaving the boiler at a high temperature, say 450 to 550 deg., carries along with it the heat absorbed in raising it to this point. If 15 lb. of air are used to burn 1 lb. of fuel, the products of combustion will weigh 16 lb. Assuming a stack temperature of 460 deg., an atmospheric temperature of 60 deg., and the specific heat of the gases as 0.24, the heat lost in each pound of air and gas passing out the stack is 0.24 x (460-60), or 96 B.t.u., or in the 16 lb. of the products of combustion, 1536 B.t.u. Assuming that the coal has a heating value of 12,000 B.t.u. per pound, then the percentage of its heat passing up the stack in the gas resulting from its combustion is about 12 per cent of the total—an unpreventable loss. If, however, instead of using the correct amount of air, i. e., 15 lb., the fireman, because of improper firing, holes in the fires, air leaks through cracks in the setting, porous fire bricks, etc., is using say 30 lb. of air to secure combustion of a pound of coal, the products of combustion will amount to 31 lb., in which case the heat lost up the stack per pound of coal amounts to 0.24 x 31 x (460-60), or 2976 B.t.u., or based on 12,000 B.t.u. coal, 24½ per cent of the heat value of the coal, or double the loss that should be encountered.

From the preceding, it will be appreciated that the chimney heat loss increases practically directly with the amount of air used for securing combustion of the coal. It is apparent, therefore, that if good thermal efficiency is to be obtained, the weight of air used in the combustion of the coal must be kept as nearly to the 15 lb. mark as possible.

It has been found that there is a definite relation between the percentage of CO_2 in the flue gas and the chimney loss, hence the analysis of the flue gas for CO_2 offers a convenient and accurate gage as to the

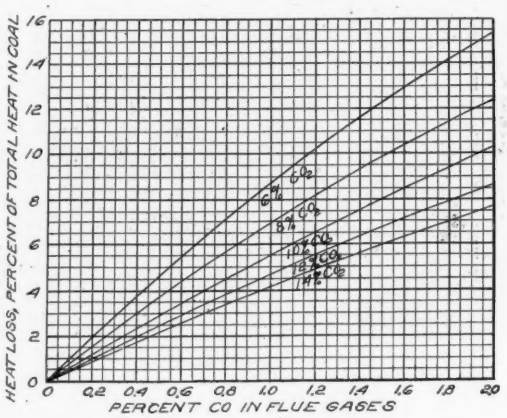


FIG. 2. RELATION BETWEEN THE PERCENTAGE OF CO IN THE FLUE GASES AND THE HEAT LOSSES DUE TO THE ESCAPE OF CO. EACH CURVE GIVES THE LOSS FOR ONE CONSTANT PERCENTAGE OF CO_2 AS INDICATED UNDER EACH CURVE

quantity of air being used for combustion, thus enabling steps to be taken to maintain the best efficiency.

This relationship is expressed graphically in Fig. 1, showing data secured by the U. S. Bureau of Mines, the horizontal scale representing the percentage of CO_2 in the flue gases, and the vertical scale representing the heat loss in the chimney gases, the curves being drawn

to represent several common flue gas temperatures. Taking the 475 deg. flue gas temperature for example, it will be noted that with 15 per cent CO_2 (practically perfect operating conditions) the loss of heat in the flue gas amounts to about 12 per cent, an unpreventable loss as outlined above. However, with 10 per cent CO_2 in the flue gas, the loss amounts to about 17½ per cent (representing a preventable loss of over 5 per cent), while with 5 per cent CO_2 in the flue gas the loss mounts up to 35 per cent (representing a preventable loss of fuel to almost 25 per cent).

The investment in a flue gas analysis outfit which will point out these conditions that are resulting in losses in the flue gas of say 17½ or 35 per cent instead of the 12 per cent loss which is unavoidable, is certainly worth while for every plant no matter how large or how small.

The flue gas analysis outfit, it must be understood however, merely points out an inefficient condition, and does not remedy it directly. It is up to the operator to take steps to cut down excess air if the CO_2 analysis shows that it is present. Excess air may be due to holes or spotty fires, air leaks through cracks in the boiler settings, porous brick settings, etc.

Incomplete Combustion Losses

In addition to checking the amount of heat being wasted because of the presence of excess air in the chimney gases, flue gas analysis also acts as a check against loss from incomplete combustion, which will amount in the average plant to from 5 to 10 per cent of the heat value of the coal.

By analyzing the flue gases for CO_2, O_2 and CO, the incomplete-combustion losses due to the carbon burning to CO (carbon monoxide) instead of to CO_2 (carbon dioxide) can be determined.

When one pound of carbon burns to CO_2, the combustion generates about 14,500 B.t.u. of heat. When one pound of carbon burns to CO, only 4800 B.t.u. are generated, thus 10,000 B.t.u. are lost for every pound of carbon which is incompletely burned to CO instead of to CO_2.

Figure 2 shows the relation between the percentage of CO in the flue gases and the heat loss due to the escape of CO, each curve representing the loss with different percentages of CO_2 the curves being compiled for coal containing 82 per cent carbon, and having a heat value of 13,500 B.t.u. It is apparent from the position of the curves that the higher the percentage of CO_2, the lower is the heat loss for the same amount of CO, thus with 1 per cent of CO and 6 per cent of CO_2 the loss is 8.8 per cent of the total heat in the coal, whereas if the percentage of CO_2 in the gases is 14 per cent, 1 per cent of CO in the gas effects a loss of only 4.2 per cent.

The flue gas analysis shows up this incomplete combustion by the detection of the undesirable CO in the flue gases, and again warns the operator that waste is taking place, and that steps should be taken to eliminate them.

Incomplete combustion may be caused by an insufficient supply of air to insure complete combustion, too thick firing, lack of proper mixing of the air with the combustible rising from the fuel bed, broken down baffle walls, insufficient draft, overload conditions, etc.

Flue gas analysis apparatus can be obtained for periodically testing and analyzing independent samples, or recording apparatus can be obtained for continuously analyzing and recording on a chart the CO_2 content. In the larger plant, the continuous recording instruments are doubtless of benefit because they give a constant guide for the firing force to follow and act as a visible check on the efficiency of their work, the CO_2 records often forming the basis for a firemen's bonus system to encourage best combustion results.

In very small plants and those operating at full load only for short periods, it should only be necessary to make periodical tests, at first making the test frequently until the most desirable and efficient standard practice as to firing, draft, etc., has been determined, and then analyzing the gases at less frequent intervals to act merely as a check to insure that the desirable conditions are being maintained.

Of all the power plant instruments the flue gas analysis apparatus, taking into account its low cost and the tremendous savings it can lead to, should prove to be one of the most profitable and satisfactory investments that can be had.

Draft Gages

The draft gage is the simplest, cheapest and yet one of the most essential instruments used for indicating

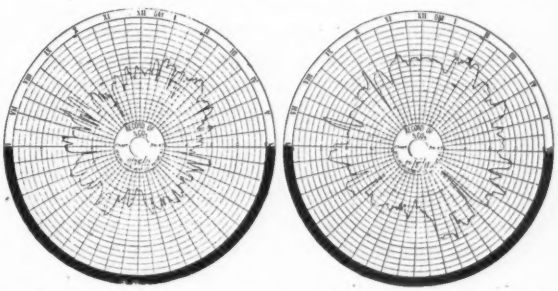


FIG. 3. TWO TYPICAL CO_2 CHARTS. THE CHART AT THE LEFT MADE SHORTLY AFTER THE INSTALLATION OF THE CO_2 MACHINE SHOWED A CO_2 PERCENTAGE (AVERAGE) OF 8.48—FUEL CONSUMPTION 11 TONS PER DAY. THE CHART AT THE RIGHT WAS OBTAINED SEVERAL WEEKS LATER AND SHOWS 11.75 AVERAGE CO_2, RESULTING IN CUTTING DOWN THE COAL CONSUMPTION TO 10 TONS PER DAY

combustion conditions in boiler practice. The draft gage is just as essential to the successful operation of the furnace as the water column is to the maintenance of proper conditions in the boiler.

Under ordinary conditions probably no other purchase an engineer can make would produce such a large percentage of return on the investment as a draft gage, first, because of its extremely low cost, and second, because any economies it leads to directly affect the coal bill, the largest item of expense encountered.

Successful and efficient furnace conditions, i. e., proper combustion, are dependent directly on furnishing an adequate and proper supply of air to secure complete combustion, and this condition can be obtained by providing proper draft conditions. And for showing the operator whether just sufficient or too much or too little draft is being used, the draft gage is an absolute necessity.

The percentage of CO_2 and CO in the flue gas—the indication of how efficient the combustion is—depends

directly on the amount of draft carried. As the draft increases above a certain point the percentage of CO_2 will fall, while as the draft falls below that point the CO content will rise, either condition indicating improper combustion, hence a direct loss of fuel. In other words, to secure any good CO_2 percentage it is necessary to pay close attention to draft regulation, and for this purpose a draft gage is of vital importance, because it shows the operators at a glance just what draft is being carried, and whether it is above or below the given standard draft to which they are working. Consequently the savings pointed out as following the use of flue gas anal-

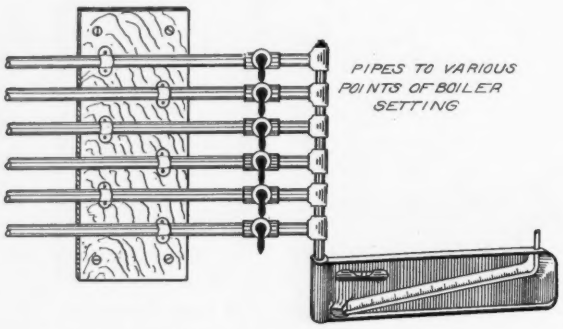


FIG. 4. SINGLE DRAFT GAGE CONNECTED TO GIVE DRAFT AT VARIOUS POINTS OF GAS PASSAGE

ysis are also dependent to a great extent on the use of proper draft gages.

Furnace draft varies in accordance with many features, such as

The kind of coal used.
The kind of grates used.
Thickness of fires carried.
Condition in which fires are kept.
Presence of soot.
Height of stack.
Outside temperature.

The proper draft which should be carried should be determined by suitable tests run in connection with flue gas analysis, i. e., the draft should be ascertained that will give the highest percentage of CO_2 in the flue gas, in other words, insure the most complete combustion. This standard draft should then be established as the draft to which the firemen should work. If the fires become thin or holes appear in the fuel bed the draft will decrease below the proper point indicating a loss of heat in excess air passing up the stack. If the fires become too thick or become clogged with clinker, or the grates become congested with clinker, the passage of the air through the fire is hindered and the draft pressure will increase, showing that sufficient air is not being provided, and that therefore a loss from incomplete combustion is resulting.

While as pointed out above, the draft gage will prove to be a good investment for the reasons stated, i. e., in indicating when the fires need attention, the most complete results can be obtained when the draft gage is used in conjunction with flue gas analysis, because then the draft standard which gives the best percentage of CO_2 can be determined for constantly changing conditions, such as changes in the outside air temperature, etc.

The answer to the question, does the installation of a draft gage pay is unquestionably "yes." An ordinary draft gage, representing as it does an expenditure of from $10 to $15 can readily point out the way for savings that in some plants would pay for the purchase of the instruments in a single day's operation.

Recording draft gages have also been developed, but this refinement is not absolutely necessary if the operators form the habit of noting the draft pressure just as they constantly observe the steam pressure gage. In a plant fitted with a complete set of instruments and where the records for the week or month are tabulated and intelligently studied, then the recording feature is of course worth while. Very frequently the draft record can be made directly on the chart on which is recorded the CO_2 percentage, giving at one glance the relation between these two very important factors. Where the firing force must be watched to keep them up to the mark, the fact that a record is being made of their work as far as the draft conditions are concerned would doubtless also tend to better efficiency.

The matter of soot collection on the tubes of boilers has a very important bearing on the matter of draft, and the increase in draft pressure indicated by the draft gage will often reveal the necessity for cleaning off the soot from the tubes.

The study of the draft gage will also often point the way to improved operating conditions and increased capacity through the installation of mechanical draft apparatus and blowers. In a small plant operating two 150-hp. boilers the installation of a draft gage recently showed that less than one-half of the proper draft required to burn the coal on the grates was being supplied. When this necessary draft was supplied by means of a fan blower it was found that a saving of fuel of about

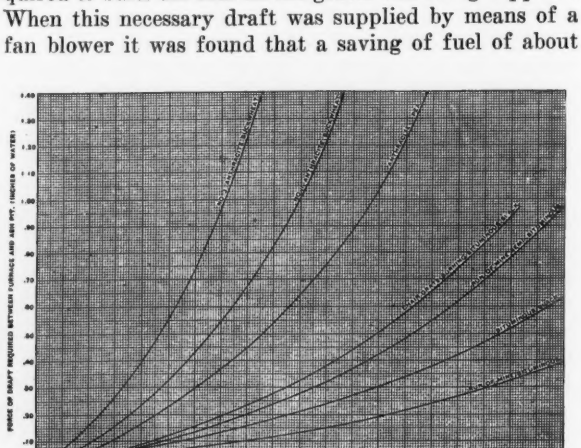


FIG. 5. DRAFT REQUIRED TO BURN VARIOUS KINDS OF COAL

15 per cent was effected, and then later on it was found that the capacity of the boilers was increased so greatly that the load previously requiring two boilers was very nicely taken care of by one unit. Many plants requiring increased capacity can secure this out of their present boiler installation by installing mechanical draft, and in getting a line on the requirements in these cases the draft gage plays a very important part.

Because of varying load, fire and draft conditions which may exist in different boilers in the same plant,

even though they be connected to a common chimney and steam header, it is very desirable to treat each boiler as an individual unit, and therefore it should pay to have a draft gage on each boiler. Or by means of piping and cut-out valves the one gage can be used for checking the draft in each boiler alternately, or in various parts of the same boiler. Figure 4 illustrates a draft gage piped up to indicate the draft between various parts of the same boiler structure. The same general scheme could be used for checking the draft for different boilers.

For most practical purposes an indication of the furnace draft, i. e., the draft where the fuel is burned, will supply a sufficiently accurate gage to guide the operator towards most efficient results, especially when used in conjunction with CO_2 analysis.

However, where high boiler efficiency is necessary in order to maintain capacity, and where high overloads are carried, it is desirable to take draft readings from several portions of the boiler setting, such as below the fuel bed, over the fire, in the second pass, in the last pass, in the breeching, in the stack, etc.

The draft readings taken from the various parts of the setting enable an intimate analysis to be made of furnace conditions, and also indicate how efficiently the furnace gases are being distributed through the boiler passes, and hence how efficiently the heat transmission is being accomplished.

For example, if the draft loss between any two parts of the setting increases over the amount that has been determined as indicating most efficient results, it is a good sign that there is probably an accumulation of soot on the boiler tubes, which is retarding the proper flow of gases and heat transmission. Or else there is occurring local infiltration of air through the setting, which overloads with inert gases the effective areas through the boiler tubes.

If the draft differential decreases, then it is probable that there is some defect in the baffling arrangements; some of the baffling may have fallen away, or has cracked or deteriorated, permitting the short circuiting of the hot gases to the stack without properly contacting with all the heating surfaces, resulting in a high flue temperature, loss of heat, and reduction in effective boiler capacity.

When the multiple draft readings all read higher than standard it is usually a certain sign that the boiler is being over-loaded, the high readings resulting in the passage of increased volume of gases. At extra light load, for the same reason, the draft readings will all fall slightly.

The multiple draft system also makes possible a more intensive study of firing conditions because the actual pressure drop through the fire can be observed, and the thickness of the fuel bed, method of cleaning, etc., regulated accordingly. Often this intensive study will lead to beneficial changes in grates, grades of coal, etc.

Especially in connection with the operation of stokers is this indication of the flow of air through the fuel bed of assistance in maintaining efficient conditions, since the amount of air required will vary for different types of stokers, different coals, etc.

A study of the draft differentials through the boiler may also lead to a re-arrangement of the baffling which will result in increased capacity from the same unit due to the passage of a greater quantity of the hot gases.

While the multiple draft gage system involves more piping than the single gage, the cost of the instrument is not considerable over that of an ordinary good draft gage, hence the expenditure for the provision for multiple readings is well worth while, because of its low extra cost, especially if the operators will take advantage of the information secured.

As showing the variations in draft required for burning different grades of coal, Figure 5 chart is also reproduced.

Engine Stop Systems

·Descriptions of Modern Mechanically and Electrically Operated Safety Devices to Protect Engines Against Overspeeding

FLYWHEEL explosions are caused by overloading or overspeeding of the engine. Overloading may be produced by: (1) clogging of the factory machinery, (2) unusual number of machines being forced simultaneously, (3) improper handling of friction clutches, (4) by the sudden release of a short circuit if the engine drives electrical machinery, (5) sudden stoppage of the engine, due to obstructions or defects.

Centrifugal force causes the flywheel to explode when overspeeding or racing occurs, which condition may be produced by : (1) improperly designed governor, (2) slipping of greasy governor belt, or breaking of governor pulley, (3) derangement of governor by internal or external causes, as when a stem sticks or a rod breaks, (4) derangement of valve gear, (5) sudden reduction of load, as when the main driving belt breaks, or an armature burns out.

Additional contributing causes are: (1) failure of some part of an engine, as when its bed breaks, or its shaft fails, (2) breakage of an idler pulley or driving pulley, throwing fragments into the governor or valve gear.

Flywheel accidents are commonly described in terms of wrecked engines, ruined machinery, damaged buildings, and deaths or injuries to persons in the path of the flying pieces. Depending upon the size of the wheel and its immediate surroundings, the total loss incurred will vary, averaging $10,000 for wheels 10 ft. in diameter and reaching to $100,000 or more for wheels 30 ft. in diameter.

To provide a safe-guard in the form of an automatic trip or engine stop, a number of reliable devices have been designed, which operate either mechanically or electrically. Described herewith are some of the most important types. Where engines are operated condensing, an automatic vacuum breaker is usually provided with the engine stop.

Golden-Anderson Combined Throttle and Automatic Stop Valves

Three methods of operation are possible with this valve, sectional views of which are shown in Fig. 1 and attachments may be provided, as desired, for one or all of the following systems offered by the Golden-Anderson Valve Specialty Co., of Pittsburgh.

1. Automatic operation—By a centrifugal engine shaft attachment and steam pilot valve or electric switch connected as shown in Fig. 2. When the flywheel speed exceeds the safe limit, the centrifugal action of the balanced weight trips the steam pilot valve or electric switch causing the trouble valve to close, stopping the steam flow to the engine.

2. Electric operation—By locating any number of switches at remote points, the closing of which actuates an electric solenoid and trips the latch at the pilot valve.

3. Emergency operation—By steam pipe connections through which the release of steam from chamber F of the valve may be affected.

In describing the operation of this valve reference is made to the section views shown in Fig. 1, in which the valve is in the closed position. Initial steam pressure enters at the inlet, passing through port C to the top of piston H and also through G to the filling space F between piston H, thus balancing the piston. Coil spring B counteracts the weight of the piston H and normally keeps it in the open position. A bypass of steam is secured through the valve disc E, and by raising spindle I slightly, steam passes through the ports D equalizing the pressure before opening the valve to full area.

Whenever the valve is automatically, electrically or emergency operated, releasing steam from chamber F, the unbalanced pressure of the steam passing through the port C to the top of the piston H immediately closes the valve and stops the steam supply to the engine.

Strong Engine Stops

In case of overspeeding of the engine, these stops are operated automatically by the speed limit or by the hand trip or from circuit closing stations. Mechanical operation is provided for all stops and when remote control is desired, the electrical attachments are added to the mechanical equipment. These stops are made by The Strong, Carlisle & Hammond Co., of Cleveland, O., as independent quick closing valves or as combined throttle and quick closing valves. They are built in the horizontal, vertical or angle types.

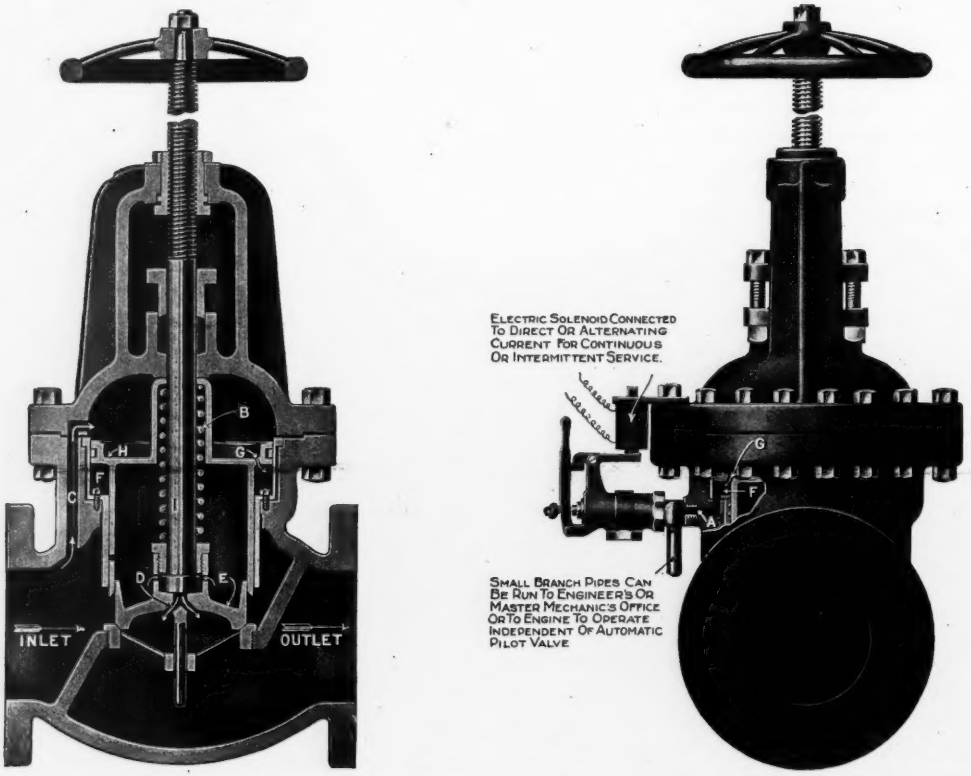


FIG. 1. SECTIONAL VIEWS OF GOLDEN-ANDERSON COMBINED THROTTLE AND AUTOMATIC STOP VALVE

Figure 3 shows the shaft attachment and speed limit head. The shaft attachment may be arranged for attaching to the spokes or rim of the flywheel or to the end of the shaft when there is insufficient room on the shaft to accommodate the band. In case of overspeeding, the arm of the shaft attachment is thrown outward by centrifugal force with the increasing speed until the weight arm strikes the trip finger of the speed limit head.

In acting, the automatic release of the cable or closing of the electrical circuit at the speed limit, or the operation of the circuit closer or cable pull stations, permits the counter or upper weight to fall, removing the support holding the disc lever in position. This action permits the valve to close by gravity assisted by the

velocity of the steam. To prevent slamming, the valves are provided with a dash pot which acts as a cushion just before the disc reaches its seat. Each valve is provided with an internal bypass to equalize the pressure on the disc and permit an easy opening. See Fig. 4.

Shown in Fig. 4A, is a sectional view of the combined throttle and quick closing valve without the electrical

Inside of the valve casing is a steam balanced rotary valve, which is in the form of a curvilinear plate, as shown in Fig. 5, with triangular end wings. As the rotating center is offset from the true center on which the valve is turned, there is no friction between the valve face and its seat, the only contact being made when the valve is in the closed position.

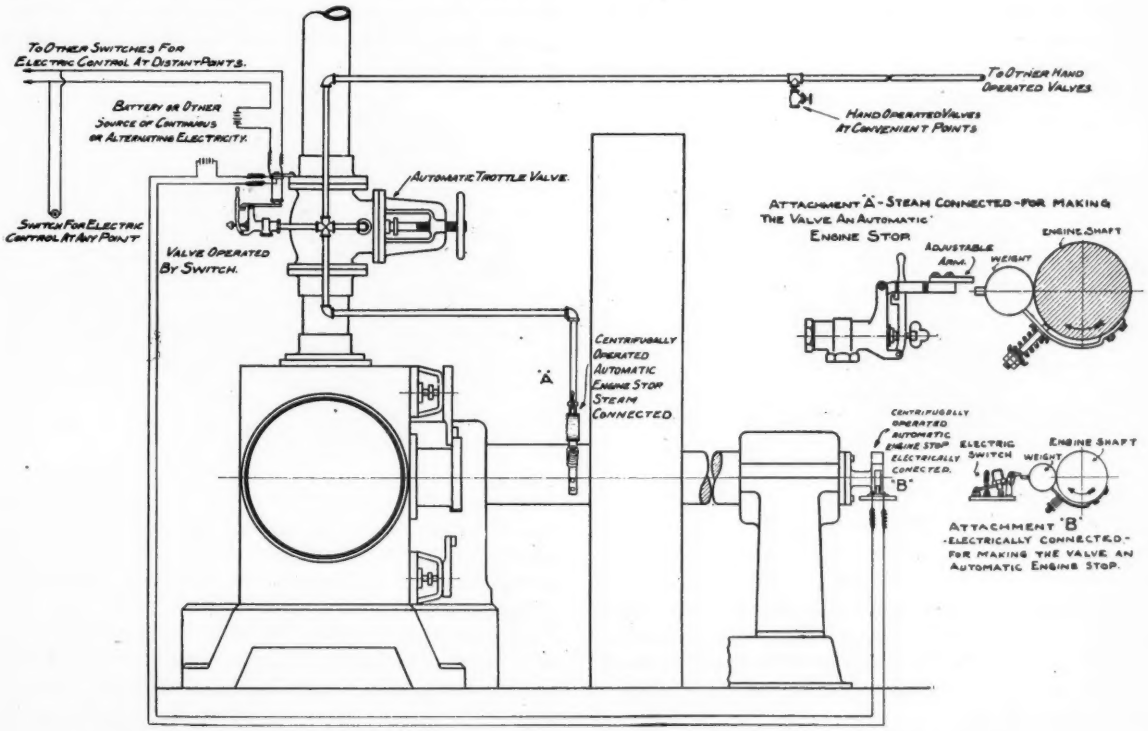

To Other Switches For Electric Control At Distant Points.
Battery or Other Source of Continuous or Alternating Electricity.
Switch For Electric Control At Any Point
Valve Operated By Switch.
Automatic Throttle Valve.
To Other Hand Operated Valves.
Hand Operated Valves At Convenient Points
Attachment 'A' - Steam Connected - For Making The Valve An Automatic Engine Stop
Adjustable Arm.
Weight
Engine Shaft
Centrifugally Operated Automatic Engine Stop Steam Connected.
A
Centrifugally Operated Automatic Engine Stop Electrically Connected.
Electric Switch
B
Attachment 'B' - Electrically Connected - For Making The Valve An Automatic Engine Stop.

FIG. 2. INSTALLATION PLAN GOLDEN-ANDERSON COMBINED THROTTLE AND STOP VALVE SYSTEM

attachments. The quick closing feature of this valve is similar to Fig. 4 with the added feature that it can be used as a throttle valve.

Falls Automatic Engine Stop

Made by the Falls Machine Co., of Sheboygan Falls, Wis., is an automatic engine stop which is adapted for

Outside the casing and at the end of the valve stem is the weighted valve lever as shown in Fig. 6, which, when released, travels a short distance before engaging the stem and carrying it down, rotates the valve to the closed position. The additional travel produces a hammer blow on the stem, insuring positive action. As

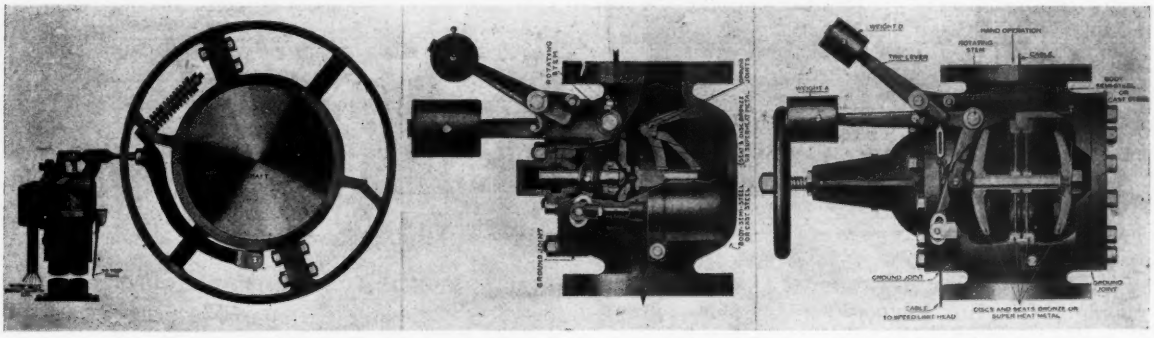


FIG. 3. STRONG SHAFT ATTACHMENT AND SPEED LIMIT HEAD
FIG. 4. STRONG AUTOMATIC STOP VALVE

FIG. 4A. MECHANICALLY OPERATED STRONG COMBINED THROTTLE AND QUICK CLOSING VALVE

either vertical or horizontal steam mains and for use with direct or alternating current, battery sets, on an open or closed circuit, or completely mechanical, requiring no electrical current.

there is no packing in the valve, there is no chance of it sticking.

An open position of the valve is secured by the lever lock, the end of which consists of a roller fitting into

a detent in the lever end and held in place by the end of the lever lock diametrically opposite, which is in the form of a weight.

Release of the valve lever is accomplished electrically on both alternating and direct current and either closed or open circuit, or mechanically without use of electricity.

A counterweight is suspended on an arm and being direct connected to both speed limit apparatus and stopping stations in the plant by either of the above described methods, the counterweight is released upon opening or closing a circuit or mechanically operating either the trip head or hand stop station. The counterweight being released drops, developing a hammer blow which disengages the lever lock letting the lever weight fall by force of gravity and close the valve. There are no rotating parts to jam or set. The valve is actuated entirely by gravity.

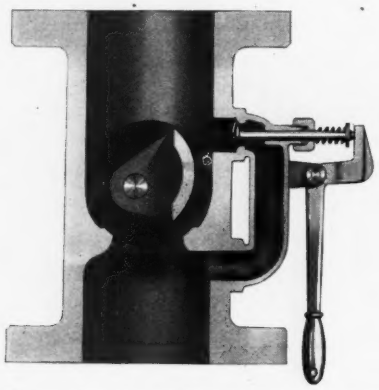


FIG. 5. SECTIONAL VIEW OF FALLS STOP VALVE

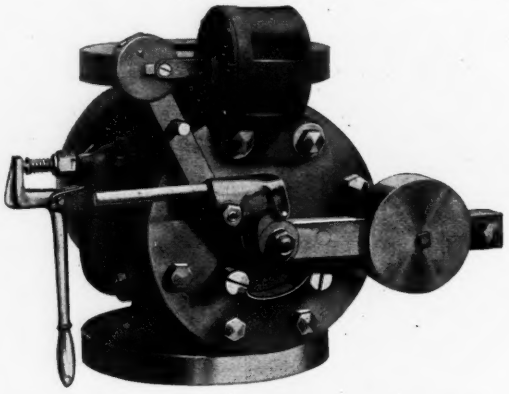


FIG. 6. OPERATING PARTS OF FALLS ENGINE STOP

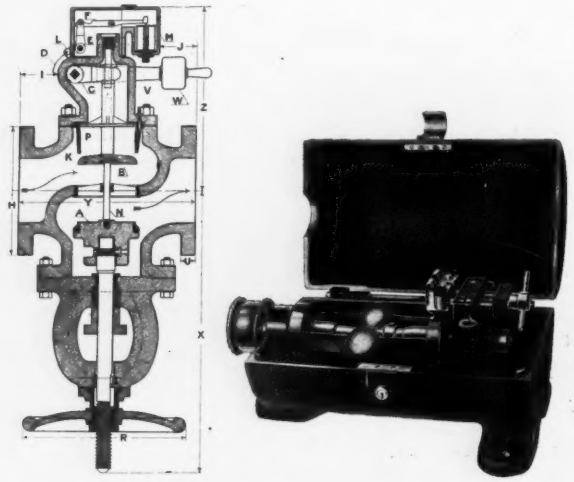


FIG. 7. CONSOLIDATED AUTOMATIC ENGINE STOP
FIG. 8. SPEED LIMIT FOR CONSOLIDATED ENGINE STOP

The speed limit device consists of a centrifugal governor mounted on a split collar which is clamped tightly on the engine shaft. Projecting through a slot in the face of the split collar is a contact pin. When running at normal speed, the governor is held tight to the shaft, but when the speed is increased to any predetermined point, the centrifugal force of the weighted part of the governor causes the contact pin to describe a wider circle, strike the speed limit contact which closes or opens an electric circuit, controlling counterweight arm. The mechanical speed limit gives a sharp pull to a wire cable which draws the lever lock out of contact.

Consolidated Engine Stop

This valve stop is the equivalent of 2 valves, for if placed in the steam line, it may be employed as an ordinary globe valve. It is built in the horizontal or vertical type. The throttle and automatic features are not combined in one action, but the two discs operate independently.

Figure 7 shows a sectional view of the valve placed in a vertical position. Being of the standard globe valve type, the valve stem and disc A may be operated by the hand wheel, and they also act as a guide for the valve system N. Valve disc B and stem N are free to slide in supporting guides. Fork C is mounted upon a stud, which also carries the trip lever D and the weight lever W. This stud does not slide but makes a ⅛ turn through a special stuffing box. M is a specially constructed solenoid wound with a patented heat and moisture proof wire.

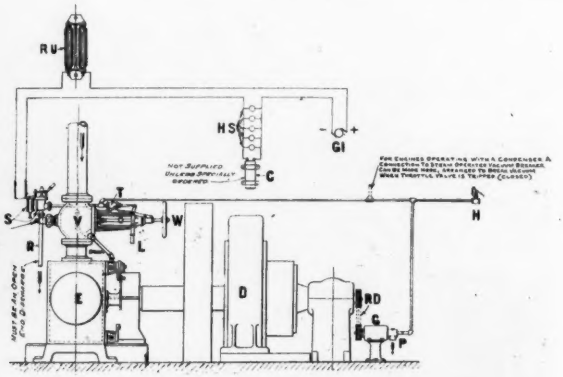


FIG. 9. SCHUTTE COMBINED TRIP AND THROTTLE VALVE

When M is energized from a switch or automatic speed limit, the armature lever F releases E, thus permitting L to rotate and disengage D and W, causing the fork C to force the disc B to its seat and cut off the steam supply.

After this valve has operated it cannot be reset without previously turning down the handwheel. This precaution entirely eliminates the danger of suddenly throwing a full head of steam upon the engine.

Ordinarily, the speed limit for this stop valve is driven from the engine shaft by means of a belt, rope, chain or gears at a speed 3 to 5 times that of the engine to secure sensitive operation. It consists of a flyball type centrifugal governor, as shown in Fig. 8.

Schutte Engine Stop Systems

To meet various conditions, the Schutte & Koerting Co., of Philadelphia, have devised a number of engine stop systems which may be formed from different combinations of the following parts: (1) an independent governor, either electrically, steam, or mechanically actuated, (2) a combined trip and throttle valve, operated electrically with open or closed 110 or 220-v., d.c. circuits, by steam, by either steam or an electrical open circuit, or mechanically, (3) a butterfly valve, operated by open or closed electrical circuits drawing current from 110 or 220-v., d.c., lines or from batteries.

In the combined steam and electric system shown in Fig. 9, 3 methods of operation are possible. First, by the steam operated governor, G, which, should the predetermined speed be exceeded, opens the relief valve, P, thus relieving the pressure from the under side of the piston in the steam trip cylinder, T, and the pressure on top of the piston causes the toggle links to snap over center and thus trip the valve. Second, any number of hand levers H may be used for shutting the main valve in a similar manner from points not more than 30 ft. distant from the main valve. Third, electrically, when one of the hand push switches, HS, located at any distance desired, is pushed, a contact is made and the solenoid, S, immediately opens the relief valve, thus again relieving the pressure from the steam cylinder, T, as previously described.

In addition to these methods the valve may be tripped by the hand lever, L, of the main valve or the valve may be closed by the handwheel, W, which is independent of the tripping devices.

In Fig. 9, D, is a generator, E is an engine cylinder, G is a speed limit governor, GI is a source of current, R is the discharge pipe from solenoid operated relief valve, RD is a rope drive and sheave, and V is the combined trip and throttle valve.

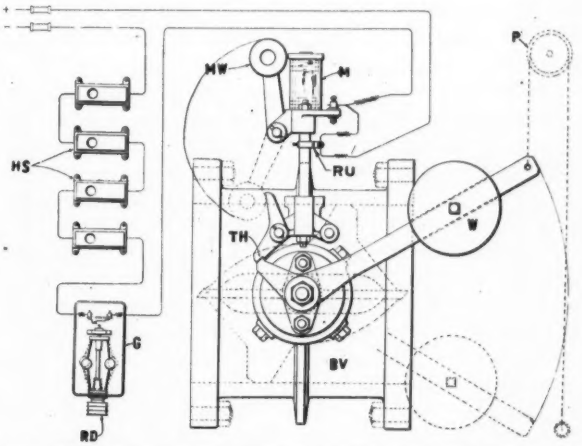


FIG. 10. SCHUTTE BUTTERFLY ENGINE STOP SYSTEM WITH ELECTRIC SPEED LIMIT GOVERNOR

Figure 10 shows a Schutte & Koerting stop system consisting of a butterfly valve, electric speed limit governor and hand push switches. This is a closed circuit system operating with 110 or 220-v., d.c., which, in energizing the magnet, M, holds up the magnet weight, MW. When the circuit is opened either by the action of the governor, G, or by one of the hand switches, HS, the magnet weight, MW, drops and strikes the trip hook, TH, permitting the weight, W, to carry the butterfly valve, BW, to its seat.

Combining Indicator Cards

Method of Doing This With Diagrams Taken From Tandem Compound Engine. By G. S. Blankenhorn

FEW operating engineers realize the importance of the combined indicator diagram and yet it is just as important to them as to the designer. By taking cards from the cylinders of a compound steam engine, the operator can tell if his valves are set correctly, but does he know whether his receiver pressure is right, for best economy? This is important and can be determined only by means of the combined card.

I have assumed that the reader knows something about the combination of indicator cards, so have not gone into great detail, but have endeavored to touch upon points that are usually not quite clear to many.

The engine, which we will say is of the compound type with 12 and 22-in. cylinders and a stroke of 30 in., operates at a speed of 120 r.p.m. under a steam pressure of 160 lb. gage, a receiver pressure of 37 lb. gage and a vacuum of 26.4 in. of mercury. The diameter of the high-pressure piston rod is 3⅜ in., while that of the low-pressure piston rod is 3⅝ in.; the indicated horsepower of the engine is 250.

Actual Indicator Cards

Going over the crank end of the high-pressure card shown in Fig. 1, we find that the mean effective pressure is 52.3 lb. The indicated horsepower of a steam engine may be determined by means of the following formula: P L A N ÷ 33,000, where P is the mean effective pressure in pounds per sq. in., L is the length of stroke in feet, A is the area of the piston in sq. inches, and N is the number of strokes per minute. Substituting the values of these various factors, we have,

$$1 \text{ Hp.} = \frac{52.3 \times 2.5 \times (113.10 - 8.94) \times 120}{33{,}000} = 49.6$$

In a like manner, we find the indicated horsepower at the crank end of the low-pressure cylinder where, according to the card in Fig. 1, the mean effective pressure is 24.8. We have, therefore, with the other values as given above,

$$1 \text{ Hp.} = \frac{24.8 \times 2.5 \times (380.13 - 10.32) \times 120}{33{,}000} = 83.5$$

Cylinder Clearances

In each end of the high-pressure cylinder, the clearance volume is 157 cu. in.; the piston displacement in cubic inches is equal to the product of 12 squared, times 0.7854 times 30 or 3390 cu. in. The clearance volume at the head end is, therefore, equal to 157 divided by 3390, or 0.0463 cu. in., while at the crank end it is equal to 157 divided by the product of the difference between 113.1 and 8.94, times 30, or 0.0503 cu. in.

In the case of the low-pressure cylinder, the clearance volume at each end is 657 cu. in., while the piston displacement is equal to $[(22^2 \times 0.7854) - 10.32] \times 30$ or 11,100 cu. in. Head end clearance volume is equal to 657 divided by 11,100 or 0.0591 cu. in., with the same at the crank end.

Start laying out the combined diagram by first taking the length of the low-pressure card—Fig. 2—so that, as a matter of convenience, 10 in. is 100 per cent of the volume; then select a scale such that the maximum card pressure will be within the limits of the paper used. In this case, 20 lb. per inch was taken. The absolute zero line was laid out, the atmospheric line next and then the low-pressure card. The actual card was divided into 20 equal parts as was also the enlarged diagram. To determine the lengths of the ordinates of the new card, take the length of an ordinate of the old and multiply by the ratio of the old and new scales, in this case, $1 \times (30 \div 20)$, which will give the length of the corresponding new ordinate.

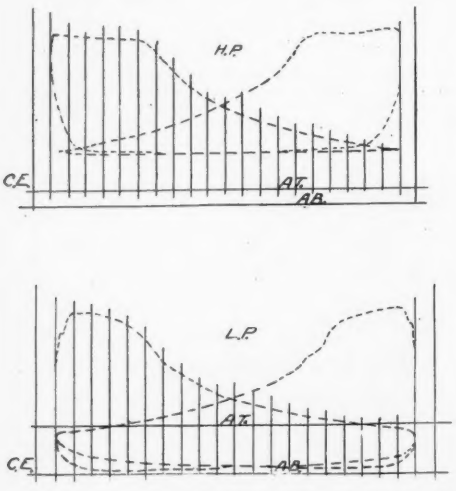


FIG. 1. MANNER IN WHICH ORDINATES ARE LAID OUT ON CARDS TAKEN FROM ENGINE

Now divide the high pressure card into 20 equal parts, and repeat the foregoing. The length of card is equal to cylinder ratio (including the rods) times the length of the low-pressure card. In this case, $(113.1 - 8.94) \times 10 \div (380.13 - 10.32) = 2.81$ in. As there is 5 per cent clearance, $2.81 \times 0.05 = 0.1405$ in. = distance from zero clearance line to compression side of card.

Next construct the isothermal line.

To get per cent cutoff in the low-pressure terms, take actual high-pressure cutoff and divide by cylinder ratio.

To get high-pressure mean effective pressure in low-pressure terms, take actual mean effective pressure from the original card and divide by cylinder ratio.

Theoretical mean effective pressure in low-pressure terms is found by running a planimeter over the isothermal line, and down a line perpendicular to the atmospheric line and tangent to the part of high-pressure card nearest to zero clearance line, then along a line tangent to lowest part of low-pressure card, this

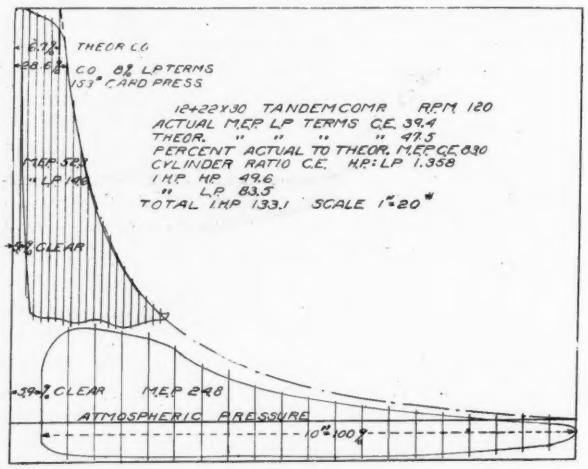


FIG. 2. THE COMBINED CARDS

line being parallel to the absolute zero pressure line or, in the case of a noncondensing engine, parallel to the atmospheric line. This area divided by length of theoretical card just used times scale (20 lb.) is equal to the theoretical mean effective pressure.

The volume of water flowing in a stream, called the "run-off," or "discharge," is expressed in various terms, which, however, may be divided into two groups —those representing rate of flow and those representing actual quantity of water. The rate of flow is generally expressed as "second-foot," an abbreviation for cubic feet per second, the unit used for measuring flowing water, as "gallons per minute," the unit used in connection with pumping and city water supply; as "miner's inch," the unit used by miners and irrigators for measuring water that passes through an orifice 1 in. square under a head that varies locally; and as "second-feet per square mile," the unit used to represent the average number of cubic feet of water flowing per second from each square mile of area drained.

The actual quantity of water is expressed by the terms "run-off in inches," "acre-feet," and "million gallons." "Run-off in inches" expresses the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface; it is used for comparing run-off with rainfall. "Acre-foot," which is used commonly in connection with storage for irrigation, is the quantity of water required to cover an acre to the depth of 1 ft.—that is, 43,560 cu. ft.

U. S. Geological Survey, Department of the Interior.

Simple, Rapid Calculating Chart

Combination of Logarithmetic Charts Serves Purpose of Slide Rule With Equal Accuracy and Greater Rapidity. By Ralph E. Turner

HAVING spent a great deal of time in solving engineering problems from formulas and in many cases having to use the same formula a great many times, the writer has given considerable thought to the use of charts and how they may be built up so as to take the place of the slide rule with an accuracy equal to that of a slide rule of like size.

Problems in multiplication, division, raising to powers, extraction of square root, cube root and fifth root and simple proportion are solved with sufficient

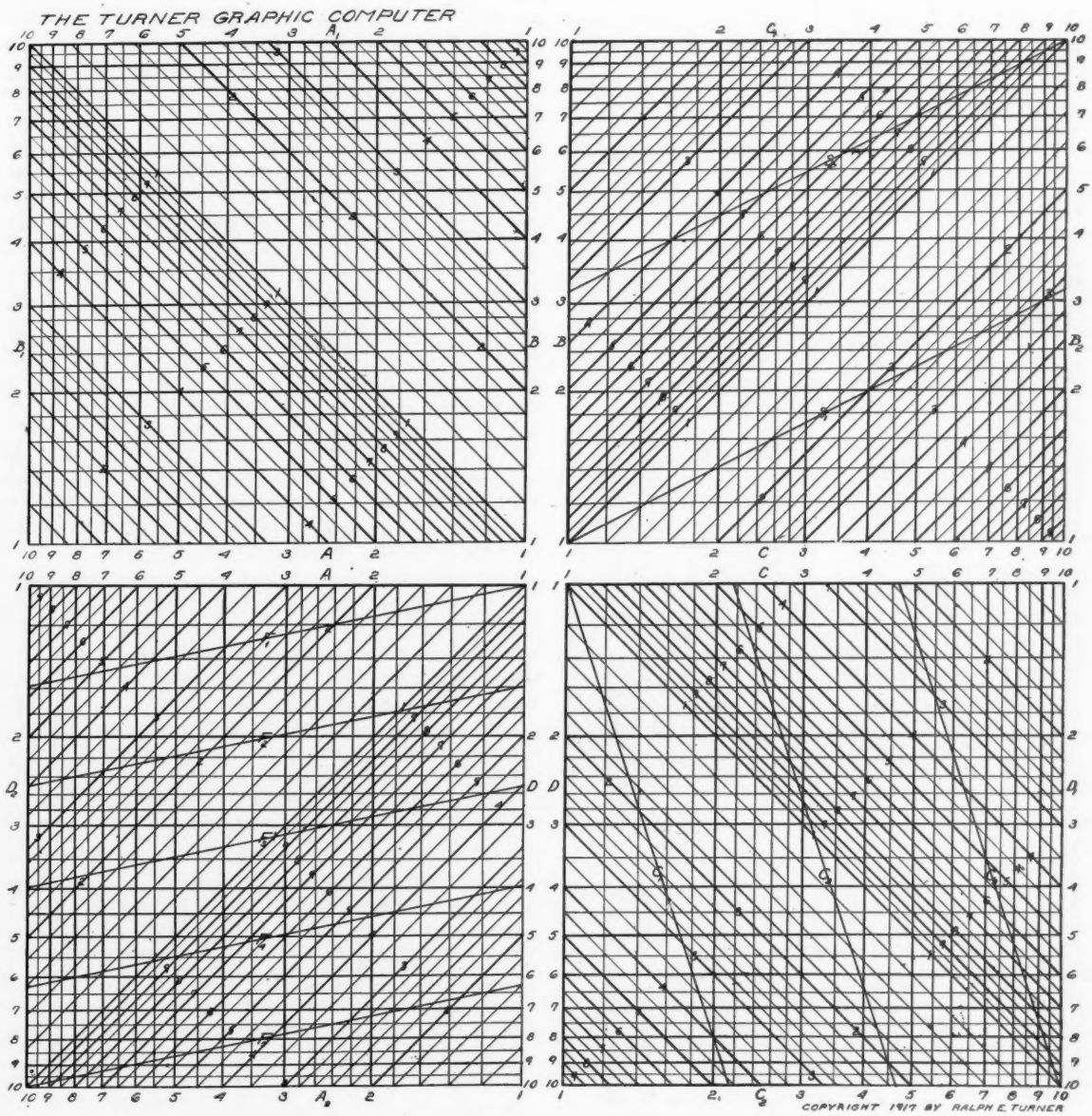


FIG. 1. SKELETON OF RAPID CALCULATING CHART USED TO DEMONSTRATE ITS USE

solve any problem to which the formula applies. A problem involving a continued multiplication and a division presented itself and in solving the problem the accompanying chart was devised, and copyrighted. As occasion presented itself, the chart has been used to accuracy for almost all engineering calculations. Its use is so simple that anybody who can follow a line with a pencil or pin point can use it with accuracy. A pair of draftsman's dividers used on the chart will aid in securing more accurate results.

For single operations, but one of the sections is used, the most convenient being that at the upper left-hand side, which we will call A-B from the scales which bound it.

To multiply, read multiplicand on scale A, follow vertically up to diagonal line representing the multiplier, then trace horizontally to the right and read the answer on scale B. To locate the decimal point, add the digits to the left of the decimal point in the multiplier and multiplicand, this will give the number of digits to the left of the decimal point in the product, if the point of intersection of the lines representing the multiplier and multiplicand is reached before the main diagonal marked "1"; if this intersection point is beyond this diagonal, substract 1 from the sum of the digits to get the number in the product.

Example: $26 \times 31 = ?$

From 26 on A trace up to diagonal 31, then trace to the right and read 806 on B. There are 2 digits to the left of decimal in both numbers, the intersection

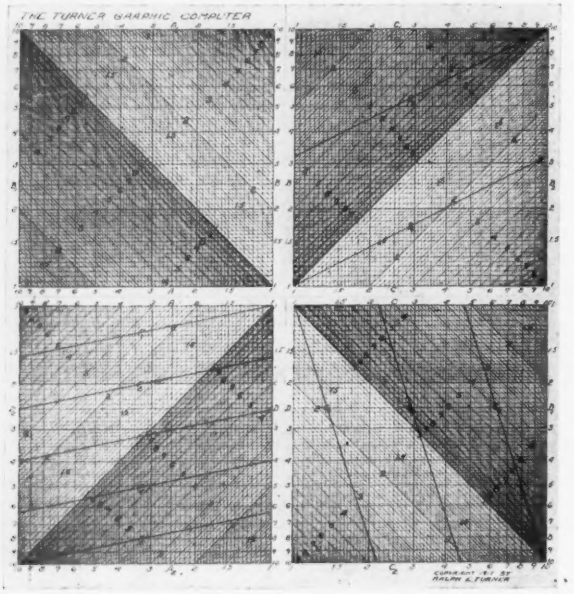


FIG. 2. REPRODUCTION OF THE CHART IN FOLDING POCKET STYLE, MUCH REDUCED

point is above the principal diagonal, so $2 + 2 - 1 = 3$, answer 806.

For division, the reverse direction is taken. Starting with the dividend on scale B, trace to the left to the diagonal representing the divisor, then vertically down to scale A. To locate the decimal point in the quotient, subtract the number of digits to the left of the decimal point in the divisor from those in the dividend, this will give the number of digits to the left of the decimal point in the quotient if the intersection point is below that is, beyond the principal diagonal, if above (on the approaching side), add 1 to the difference.

Example: $84 \div 21 = ?$

From 84 on scale B, trace to the left to 21 on the diagonal scale, then down to 4 on scale A. To locate the decimal point; 2 digits in dividend minus 2 in divisor $= 0$, now add 1 because the intersection is above the main diagonal, the answer is 4.00.

Problems in proportion are solved as follows:

From scale B as the first term, trace to the left to the diagonal representing the second term, then up or down to the horizontal line representing the third term as shown by scale B and the fourth term is represented by the diagonal at this last intersection.

Example: $7 : 5 :: 4 : X$

From 7 on B, trace to the left to diagonal 5, then down to line 4 on B and read diagonal 2.86; $X = 2.86$; to be more exact it is 2.8571 + as worked by arithmetic.

For continued multiplication, trace across scale B to the right-hand chart, which we will call B-C, to the diagonal representing the next multiplier and read the product on scale C; continue to the next diagonal on chart C-D for the next multiplier and read product on scale D; continue in like manner and read the fourth product on scale A from the diagonal on chart D-A. This process may be kept up indefinitely, always going in a clockwise direction. To locate the decimal point, as you proceed note how many times the points of intersection come on the far side of the main diagonals, then subtract this number from the sum of the digits to the left of the decimal points in the numbers multiplied, this difference will give the digits to the left of the decimal point in the final product.

Example: $56 \times 2.5 \times 321 \times 196 \times 71 = ?$

From 56 on A trace to diagonal 25, across scale B to diagonal 321 down across scale C to diagonal 196, to the left across scale D to diagonal 71, read on scale A, 625. The sum of the digits is 11; subtract 2 from this, for the number of times the intersection was on the far side of the principal diagonal, gives 9, our answer is then 625,000,000; the exact answer is 625,385,040.

Continued division is just the reverse, the lines being traced in the anti-clockwise direction. To locate the decimal point, the sum of all digits to the left of the decimal points in all the divisors is subtracted from the digits to the left of the decimal point in the dividend, then for each time the turning point was on the approaching side of the principal diagonal add 1 to the difference found above to get the number of digits to the left of the decimal point in the quotient.

Example: $7{,}350{,}000 \div 54 \div 35 \div 6.25 \div 0.735 = ?$

Starting with 735 on scale A trace down to diagonal 54, on chart D-A then to the right to diagonal 35, then up to diagonal 625, then to the left to diagonal 735, then down to scale A and read answer 847. The sum of the digits to the left of the decimal points in the divisors is $2 + 2 + 1 + 0 = 5$. Those in the dividend are 7; $7 - 5 = 2$; now add 1 for the time the turning point was on the approaching side of the principal diagonal and we have 3 as the number of digits to the left of the decimal point in the quotient. The answer is then, by the chart, 847.00; working it out by arithmetic, we get 846.53+.

In problems involving several numbers in numerator and denominator, it is sometimes convenient to multiply then divide, then multiply then divide, etc., until the problem is completed, thus using but one section of the chart.

Square root is worked on chart B-C. Point off the number in periods of two digits from the decimal point.

Starting with the number of which the root is to be extracted on scale C, trace up to the diagonal S_1 if the last period to the left has but one digit, if it has two digits trace to diagonal S_2 then to the left and read the root on scale B. Each period in the number represents a digit in the root so if you have two periods to the left of the decimal point in the number, there will be two digits to the left of the point in the root.

Example: Extract the square root of 6400. Pointing off into periods of two digits, we have 64′ 00′. We have, therefore, two digits in the last period to the left, so we start at 64 on scale C and trace vertically to line S_2 and read 8 on scale B; the root is therefore 80. If the number were 64,000, we would have only one digit in the last period to the left, so we would stop at line S_1 and read 253 as the square root in scale B.

In a similar manner, the cube root is found by means of the chart C-D starting with scale D and reading the root on scale C. In this case, of course, the number is pointed off in periods of three digits from the decimal point and the number of digits in the last period to the left determines which of three diagonals, C_1, C_2, or C_3, is to be used as the turning point.

Example: Extract the cube root of 27,000. Pointing off in periods of three, we have 27′ 000′. Thus we have two periods calling for two digits to the left of the decimal point in the answer and with two digits in the period farthest to the left we start at 27 in. scale D and trace horizontally to the right to line C_2 and read 3 in scale C, the cube root is therefore 30. If the number had been 270,000, we would have traced to line C_3 and read 646 in scale C, point this off with two digits to the left of the decimal, one for each period of the power; this gives 64.6 as the root. The root of 2700 would be found by tracing to C_1, and reading on scale C to be 13.9.

Likewise for the fifth root, the number is taken on scale A and the root read on scale D. The number being pointed off in periods of five digits from the decimal point, and here again the number of digits in the last period to the left determines which one of the five diagonals F_1 to F_5 to use.

Using this method, we find that the fifth root of 249,000 is 12, the line F_1 designating the turning point. The fifth root of 2,490,000 is found by using line F_2 to be 19; of 24,900,000 the root is found to be 30.2 using line F_3; of 249,000,000, we use diagonal F_4 and find the root to be 47.8 and 2,490,000,000 has a root of 75.7, line F_5 being used.

Raising numbers to powers may be performed by continued multiplication; but when the number is to be squared, cubed or raised to the fifth power these operations may be performed on the sections of the chart in the reverse direction to that used in extracting roots. The number of digits to the left of the decimal point in the power is readily determined as each digit to the left of the decimal in the number represents a period in the power and the subscript to diagonal used will indicate the number of digits in the last period to the left in the power.

Example: Find the cube of 32.

From 32 in scale C, trace vertically down to diagonal C_2 and read 328 in scale D. This is made up of two periods with two digits in the last period (because diagonal C_2 was the one used, neither C_1 nor C_3 intersects line 32 from scale C), the power is therefore 32′ 800′.

Numbers to be squared are read in scale B, the diagonal used is S_1 or S_2 and the power is read in scale C. Likewise the number to be raised to the fifth power is read in scale D, the diagonal used is one marked F with a subscript and the power is read in scale A.

It is quite an easy matter to work out fractional roots and powers in a similar manner, but as they are seldom used it was thought best not to complicate the chart with them.

For convenience in carrying, the chart is made to fold so as to fit the pocket; each section is 5 in. square. For desk use and where more accuracy is desired, the chart with full 10-in. sections is desirable.

Progress of the Uniform Boiler Code

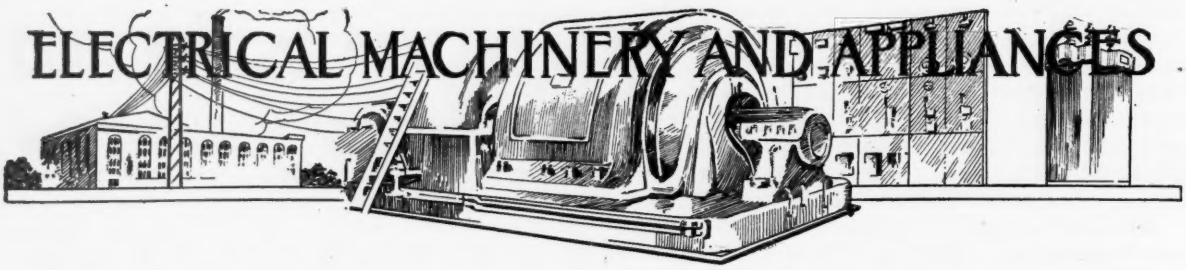
CHAIRMAN THOMAS E. DURBAN, of the American Uniform Boiler-Law Society, who resigned his position as chairman of the Administrative Council when he retired from business, but was persuaded to retain his direction of the society's activities for another year, reports that the Code is now in effect in the following states: New York, New Jersey, Pennsylvania, Ohio, Michigan, Indiana, Wisconsin, Minnesota and California, and in the cities of Chicago, Ill., and St. Joseph, Kansas City and St. Louis, Mo. In New York it has been adopted by the Industrial Commission, and applies to industrial establishments only. Active effort will be made during the coming year for the passage of the law in the following states, whose legislatures convene: Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Rhode Island, South Carolina and Virginia.

The prospects for passage are good in Georgia, Louisiana, Mississippi, Rhode Island, Montana and Iowa, and promises of its being introduced in legislatures of the other states have been made by local men whose influence is effective. The assistance of members of the American Society of Mechanical Engineers and of the National Electric Light Association will be secured in urging the passage of the law, and further notice will be sent out when the bills are introduced.

The effort of the society is to have enabling laws passed, permitting the adoption of the Code by an industrial commission, and to avoid complicating this with the addition of other legislation in regard to boiler inspection, which in many instances has been found to handicap the bill on passage.

The campaign is one of education and publicity, without which no legislation can be passed. In no states has the Code been defeated on its merits, nor have the arguments in its favor been successfully met.

BEST RESULTS so far obtained in prime movers are a horsepower-hour for 14,000 B.t.u. in large steam turbines, for 10,600 B.t.u. in gas engines, and for 7,700 B.t.u. in Deisel engines.



The Construction of a Bell Ringing Transformer

By G. F. De Silver

IT IS now generally appreciated that in buildings where 110-v. alternating current is available a bell ringing transformer comprises the most satisfactory device for furnishing current for the operation of signaling apparatus such as call bells, annunciators and alarm signals. A transformer which, when 110 v. is impressed

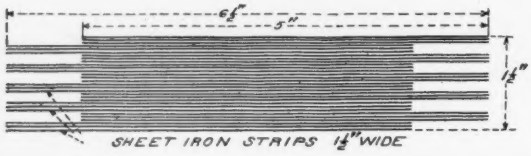


FIG. 1. ASSEMBLY OF SHEET METAL STRIPS INTO LEGS FOR TRANSFORMER CORE

on its primary, will deliver either 3, 6, 9, 12, 15 or 16 v. at its secondary, can be constructed as shown in Figs. 1, 2 and 3.

The core is built up of sheet iron strips. The softest sheet iron available should be used, and it should be as thin as it is possible to secure. To insure that the sheets will be thoroughly annealed, they should be heated to a red heat and then cooled very slowly. Cut from this material a sufficient number of strips, *A*, Fig. 3, 1½ by 3¼ in. to make a pile 3 in. thick. Also cut enough strips, *B*, 1½ by 5 in. to make a 3-in. pile. Half the *B* strips should then be piled into a core as shown in Fig. 1. After being assembled into this core, the strips should be clamped securely and wrapped with three or four layers of friction tape so that they will be held in a compact mass, as shown in Fig. 1.

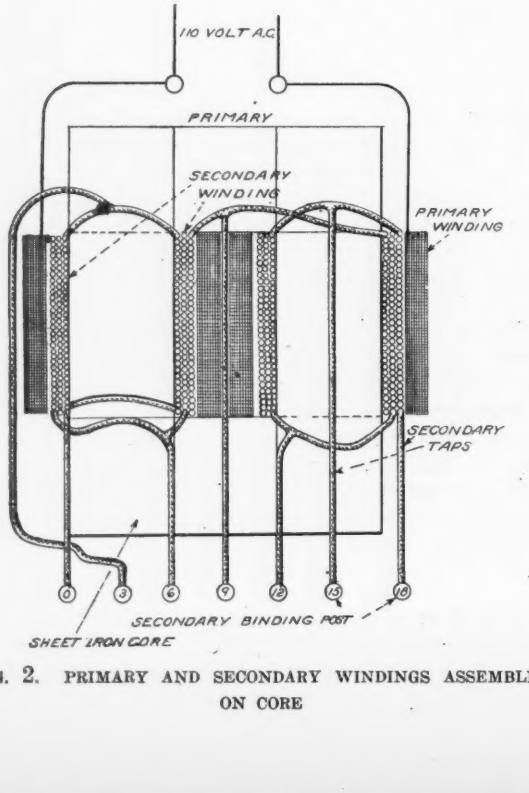


FIG. 2. PRIMARY AND SECONDARY WINDINGS ASSEMBLED ON CORE

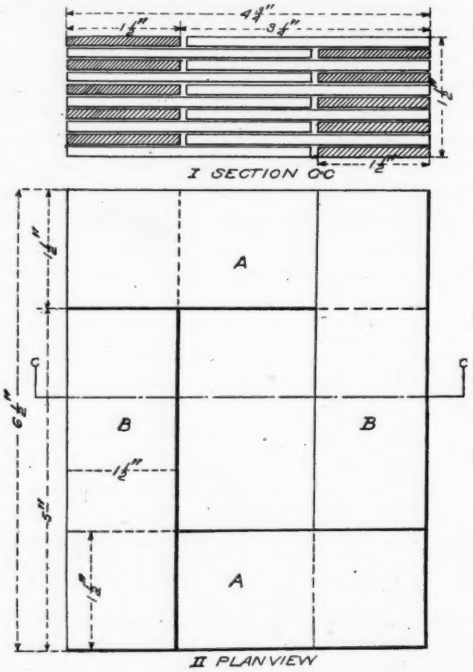


FIG. 3. TRANSFORMER CORE COMPLETE

The core should be wound as follows: On each leg, as shown in Fig. 2 for the secondary, wrap about 2½ lb. of No. 12 double cotton covered copper wire. There should be three layers of 25 turns to the layer. This secondary is connected to the binding posts as follows and as shown in Fig. 2. As each layer is completed, a tap is carried to one of the binding posts. The wire with which the secondary winding starts is connected to post *O*. From the end of the first layer a tap is carried to

post 3. From the end of the next layer, a tap is carried to post 6. Taps are carried to the posts systematically in the manner suggested and as shown in Fig. 2. The secondary winding is, of course, in one continuous length on each leg and the connections to the binding posts are taps soldered to this continuous length. The windings should be in such direction that they will correspond to those shown in Fig. 2.

The primary winding upon which 110 v. is impressed is wound over the secondary. It consists of about 6 lb. of No. 22 single cotton covered wire. There should be about six layers with 67 turns to each layer.

For insulation between the primary and secondary there should be used a stiff strong paper. Good bond writing paper will suffice. As each primary and secondary layer is completed it sh ld be thoroughly soaked with shellac so that when the winding is complete it will set into a compact mass.

After the windings on the legs are completed, the 3¼-in. strips *A*, Fig. 3, can be inserted as shown in that illustration into the ends of the *B* strips, to complete the magnetic circuit. To hold the *B* strips in position on the legs and to clamp the transformer to a back board, wooden straps can be utilized. These straps should be so arranged parallel to the *A* iron strips that they will bind the whole transformer down against a wooden base block. Small machine bolts are inserted in the wood straps to effect the clamping action necessary.

Auxiliary Lighting in Power Plants

By D. R. Shearer.

NECESSITY for auxiliary lighting in power plants is evidenced by the fact that all large stations have two or more sources of electricity for illuminating purposes. Sometimes the current is secured from small auxiliary generating or motor generator sets and frequently from storage batteries kept charged by current taken from the exciter buses or some other available source.

Small stations and isolated plants seldom have more than one source of lighting current and that is secured from the main generating unit. When trouble develops in the generator or prime mover at night, the plant is without light except such as may be furnished by a flickering oil lantern or electric pocket lamp and consequently slight repairs may cause long delays. All this is more particularly true in those plants which supply public service in the small towns and villages throughout our country. Sometimes a slight trouble will develop in a plant of this type and because there is no source of light except the main generator the operator finds it necessary to shut down until the following day when the adjustments or repairs may be made by daylight. Obviously this is considerable expense and subjects the plant management to much criticism all of which could have been obviated if auxiliary lighting could have been available.

Installation of auxiliary lighting is in general a simple and inexpensive matter and will depend on the design of the plant and operating conditions. If the exciter is separately driven, a double throw switch may be installed which will allow the lighting circuits to be thrown on either the main unit or the exciter. Even though the exciter be controlled by a voltage regulator which causes a fluctuation in the direct-current voltage, this will usually be found sufficient to give adequate light. Moreover, if the main generator is out of commission the regulator can be thrown out of circuit and the exciter voltage brought up to normal.

If the exciter is belted to the main unit some other source of lighting current becomes necessary. If the necessity justifies the expense, a small separately driven direct-current generator may be installed. This may be of just sufficient capacity to carry the lighting load on the plant buildings and may be driven by a small engine or water wheel. But if the plant is too small to warrant the installation of such a unit, there are yet means for supplying current in limited amounts.

A small storage battery can be installed to supply either 110 or less and this may be charged from the exciter buses during normal operation. All the equipment necessary is the battery and a suitable charging and control resistance. If the battery voltage is 110, a double throw switch will place the lighting circuits either on the normal supply or on the emergency battery supply as desired; but if the battery is of a lower voltage, it becomes necessary to run other circuits on which can be placed lamps of the same voltage as the battery.

In small stations, it has been found that a 6 or 12-v. automobile storage battery will give excellent service for emergency lighting. Lamps from 12 to 60 c.p. are available on the market and are usually fitted in the regular automobile sockets which are attached to a circuit run of rather heavy wire. This is necessary on account of the comparatively large amperage which it is necessary to carry to the lamps burning on a low voltage.

A battery of this type may be charged by a small rectifier or motor generator set or even from the exciter by interposing suitable resistance. It is desirable to have in the battery circuit a small double reading ammeter and a voltmeter in order that the condition of the battery may be determined at any time. Aside from periodic tests, the battery lighting should never be used except when necessary; but the outfit should be kept fully charged at all times ready for instant use should the commercial circuits "go dead."

The ampere rating of the battery should be such that with all the necessary low voltage lamps burning, at least 10 hr. service may be depended on, for it is sometimes an unpleasant duty to work all night when serious repairs have to be made.

Extension cords with reflectors and concentrating low voltage lamps are a valuable adjunct to any low voltage emergency lighting system, for it is possible to attach these cords to the circuit at any point and thus have a strong and handy light for close work. One or more of these extensions are almost necessary when scraping bearings or making governor adjustments.

In view of these facts and the frequent necessity of slight repairs to small power plants, it is remarkable that more auxiliary lighting systems have not been installed. The cost is not prohibitive and the advantages are many. As an aid to steady service and to efficiency

of operation, no plant can afford to be without some other source of light besides that secured from the regular commercial circuits which may "go dead" at any time.

Capacity of Ice Making Plants

IN A discussion of ice plants before the Milwaukee meeting of the A. S. R. E., H. Sloan brought out some interesting data that are of great value in determining proportions of installations. He bases his capacity on the water conditions for cooling and freezing purposes, taking up the process of determination in steps: 1. Refrigeration capacity for freezing ice. 2. Water needed for cooling condenser. 3. Brine temperature, freezing time, number of cans per ton, suction pressure, pipe coil surface. 4. Brake horsepower per ton of refrigeration.

Refrigeration to freeze the ice will depend on the temperature of the water in the storage tank, or from the supply if raw water is used. Assuming that this is 70 deg. F., there must be removed from the water: to cool to 32 deg. F., 38 B.t.u.; latent heat of freezing, 144 B. t. u.; cooling ice to 12 deg. F., 10 B. t. u; total, 192 B. t. u. Add to this losses from radiation, 38 B. t. u. and 230 B. t. u. must be removed for each 1 lb. of ice made. As a pound of refrigeration is 144 B. t. u.; the ratio of ice to refrigeration capacity would be $230 \div 144 = 1.6$ for water at 70 deg. F. From like computations, Mr. Sloan derives the diagram for relation between water temperature and the refrigeration per ton of ice as given in the Practical Reference Tables.

Calculating the lowest condenser pressure that can be obtained with cooling water of various temperatures, gives values as in the Table of Gallons of Condenser Water per Ton Refrigeration in the Practical Reference Tables, the values being based on heat units removed from the condenser by the water, considering that condenser temperature will be 5 deg. higher than the final temperature of the water. Study of the variation shows that using more than 2 gal. per min. per ton of refrigeration produces proportionately much less effect in reducing condenser pressure.

Temperature of brine will be between 4 and 24 deg. F., depending on the rapidity of freezing desired. The freezing time required in hours F.t. is given by an empirical rule: $F.t. = 7 \times T^2 \div D$, where T is thickness of ice in inches, and D is the difference in degrees F. between the freezing point of the water and the temperture of the brine. The freezing point will vary with the nature of the water and the concentration of salts as the freezing progresses. Cans are usually of 300 lb. capacity, and the number of cans per day per ton of ice capacity will be, $F.t. \div 3.6$.

Assuming water at 70 deg. F. and 30 B. t. u. transmitted per sq. ft. of pipe surface per hr., per 1 deg. difference in temperature between brine and ammonia, the values for lineal feet of 1¼-in. extra heavy pipe are worked out as per the chart in the Practical Reference Tables, which brings out plainly that an excessive amount of pipe—say more than 250 ft. per ton has little effect in lowering the suction pressure. The most common proportions will fall within the dotted square.

These charts and tables permit quick selection of suction and discharge pressures to get economical proportions, and the brake horsepower per ton of refrigeration is given, when these pressures are determined, by the horsepower chart of Practical Reference Tables.

Cost of Heat Losses from Bare Pipes*

By W. F. Schaphorst

BARE steam pipes have been preached against ever since the time of Watt, yet the bare pipe is still with us and losing money for its owner. Why aren't all pipes covered? Every steam pipe of any importance and size should certainly be covered unless it is a radiator pipe and is intended to radiate heat, or unless it is an exhaust pipe or something of that sort.

Perhaps the reason why owners are so slow to cover and insulate piping is because they regard the idea as being mostly "theory" and that in practice the actual money loss doesn't amount to much.

Perhaps "money loss" hasn't been brought to the attention of the owner clearly enough—forcibly enough. And the reason why this has not been done is because we have not had enough information on the subject. We have not had a good, reliable formula that would tell quickly how much money was being lost through heat in 10 hr., or in 100 hr.

In the 1915 Proceedings of the American Society of Mechanical Engineers, however, I find some good information on the subject. L. B. McMillan made some reliable and thorough tests by means of an electrical method and plotted his results in the form of a curve. I have used his results, therefore, in order to develop a trustworthy formula—a formula that will handle any ordinary case of heat loss from bare pipes. Then, with the formula as the basis, I constructed the alinement chart which is shown in the Practical Reference Table. In using the chart it is not necessary to do any figuring. Simply lay a straightedge across the chart four times as indicated by the dotted lines and the cost of the heat loss is immediately found in the right hand column.

This is the formula:

$$\text{Cost of lost heat in H hours} = \frac{(1.6 + .0056\,D)\ DHAC}{2000\,BE}$$

where D = the temperature difference in degrees F., or the pipe temperature minus the room temp.;
H = the number of hours during which heat is lost;
A = area of bare pipe in square feet;
C = cost of coal per ton of 2000 lb., in dollars;
B = B.t.u. per pound of coal;
E = boiler efficiency.

For convenience I have used these same letters to designate their various columns in the chart.

For example, take a case where we have these values:

C = $3.50
A = 100
D = 200
H = 200

*Copyright, 1917, by W. F. Schaphorst.

B = 12,000
E = 60 per cent

What is the cost of the lost heat?

The dotted lines drawn across the chart show how the answer—$2.64—is obtained in column Y at the extreme right.

Connect C and A with line CA and locate the intersection with column X. Then connect D and H with line DH and locate the second intersection with column X. Now locate the mid-point M between these points of intersection and lay out the line BM HA, locating the intersection with column HA. Lastly, run a line through that point of intersection and the 60 per cent (column E)—line HA E Y on the chart—and the final intersection with column Y gives the answer, $2.64.

By following this method any ordinary problem is easily solved. If the number of hours were 2000 instead of 200, the self-same lines shown would be used and the decimal point would be moved one place to the right, making the cost $26.40 instead of $2.64. And if, in addition, the area were 1000 sq. ft. instead of 100 the decimal point would be moved one more place to the right, making the cost $264.00. The range of the chart is therefore decidedly wide. It includes temperature differences all the way from 13 deg. F. to 500 deg. F., all heat values for coal, and a boiler efficiency range from 10 per cent to 100 per cent. I have included 100 per cent efficiency because we are gradually "getting there." The recent record of 90 per cent brings us very close to the point of desired perfection.

This chart therefore shows distinctly the money loss through bare pipes. Its aim is to influence the owner to cover those pipes. It is true that pipe covering will not save all of this money, but it will save much of it. The proportion of money saved depends entirely upon the efficiency of the covering. No covering made is 100 per cent efficient, but that efficiency is closely approached.

For example, let us cover the pipe solved above whose area is 1000 sq. ft. and which is heated for 2000 hr. Let us use a covering whose efficiency is 80 per cent. How much money would be saved in the 2000 hr., or 83.5 days?

The answer is: $264. × 0.80 = $211.00.

Pulverized Coal Demonstrates High Economy in Test

IN view of the present coal situation, the results secured in a recent 24-hr. test of a 150-hp. Brownell horizontal return tubular boiler at the demonstrating plant of the Powdered Coal Engineering & Equipment Co., Chicago, when fired with powdered coal, is of interest to fuel users of every character. The duration of the test was 23¼ hr., and on both days, Dec. 27 and 28, 1917, the temperature outside averaged about zero Fahrenheit. The boiler furnace was served by two 12-in. Pruden coal carbureters.

The coal burned was a high ash (22.09 per cent) La Salle County, Illinois, screenings, with a heating value of 10,158 B.t.u. on a dry basis. The coal was dried and pulverized in the demonstration plant of the Powdered Coal Engineering & Equipment Co., this coal preparation unit having a capacity of 60 tons of pulverized fuel per day. As burned under the boiler, the coal dust had a moisture content of 2.94 per cent. A screening test showed that 98.8 per cent passed through a 100-mesh screen and 90.5 per cent through a 200-mesh screen.

The proximate and ultimate analysis of the coal is given in Table I.

TABLE I. ANALYSES OF COAL USED

Proximate Analysis

	Dry per cent	As burned per cent
Moisture	.....	2.94
Volatile matter	37.61	36.49
Fixed carbon	36.51	35.42
Sulphur	3.79	3.71
Ash	22.09	21.44
	100.00	100.00

Ultimate Analysis.

	Dry per cent
Carbon	60.86
Hydrogen	4.32
Nitrogen	0.99
Oxygen	7.95
Sulphur	3.79
Ash	22.09
	100.00

In Table II are given the principal results and data of the test.

TABLE II. DATA AND RESULTS OF EVAPORATIVE TESTS

1. Test of Brownell tubular boiler located at plant of Powdered Coal Engineering & Equipment Co., at 2401 Washington Boulevard, Chicago, to determine evaporation.
2. Kind of furnace: Special construction.
3. Grate Surface: Grate absent; fired by two Pruden Carbureters, 12 in.
4. Water Heating Surface: 1504 sq. ft.
5. Superheating Surface: None.
6. Date: Dec. 27-28, 1917.
7. Duration: 23¼ hr.
8. Kind and size of coal: La Salle County, Illinois, screenings, pulverized 90.5 per cent, through 200-mesh; 98.8 per cent, through 100-mesh.

AVERAGE PRESSURES, TEMPERATURES, ETC.

9. Steam pressure by gage: 135.1 lb.
10. Temp. of feed water entering boiler: 145 deg. F.
11. Temp. of escaping gases leaving boiler: 609.8 deg. F.
12. Force of draft in fire box: 0.15 in.
13. Percentage of moisture in steam: 0.95 per cent.

TOTAL QUANTITIES

14. Weight of coal as fired: 17,625 lb.
15. Percentage of moisture in coal: 2.94 per cent.
16. Total weight of dry coal consumed: 17,107 lb.
17. Total ash and refuse: 3679 lb.
18. Percentage of ash and refuse in dry coal: 22.09 per cent.
19. Total weight of water fed to the boiler: 117,835 lb.
20. Total water evaporated, corrected for moisture in steam: 116,715 lb.
21. Total equivalent evaporation from and at 212 deg.: 129,554 lb.

HOURLY QUANTITIES AND RATES

22. Dry coal consumed per hour: 735.7 lb.
23. Dry coal per sq. ft. of grate surface per hour:
24. Water evaporated per hour corrected for quality of steam: 5020 lb. per hr.
25. Equivalent evaporation per hour from and at 212 deg. F.: 5572 lb. per hr.
26. Equivalent evaporation per hr. from and at 212 deg. F. per sq. ft. of water-heating surface.

CAPACITY

27. Evaporation per hour from and at 212 deg. F.: 5572 lb.
28. Boiler horsepower developed (steam, item 27 ÷ 34½): 162 hp.
29. Rated capacity, in evaporation from and at 212 deg. F. per hr.: 5175 lb.
30. Rated boiler horsepower: 150 hp.
31. Percentage of rated capacity developed: 108 per cent.

ECONOMY RESULTS

32. Water fed per pound of coal fired: 6.69 lb.
33. Water evaporated per pound of dry coal: 6.84 lb.

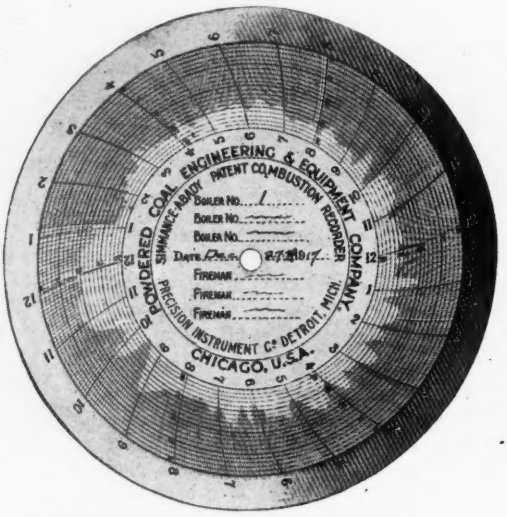


FIG. 1. REPRODUCTION OF CO_2 CHART

34. Equivalent evaporation from and at 212 deg. F. per pound of dry coal: 7.59 lb.
35. Equivalent evaporation from and at 212 deg. F. per pound of combustible: 9.73 lb.

EFFICIENCY

36. Calorific value of 1 lb. of dry coal: 10,158.
37. Calorific value of 1 lb. of combustible: 13,039.
38. Efficiency of boiler, furnace and grate: 72.5 per cent.
39. Efficiency of boiler and furnace: 72.5 per cent.

COST OF EVAPORATION

40. Cost of coal per ton of 2240 lb. delivered in boiler room (including drying and pulverizing): $4.28.
41. Cost of coal required for evaporating 1000 lb. of water from and at 212 deg. F.: $0.2793.

Figure 1 is a reproduction of the CO_2 chart obtained over a period which covers the duration of the test. It will be observed that the CO_2 content is much higher than average or usual standard practice.

The conditions under which the test was made were unfavorable from the standpoint of thermal efficiency, making it appear probable that under continuous service in ordinary weather the high boiler and furnace efficiency, 72.5 per cent, might easily be exceeded. The powdered coal was lighted under a cold boiler 3 hr. before the test was started, the average temperature of the air fed with the powdered coal being approximately 4 deg. F. Bituminous coal, of 18 per cent ash, under ordinary conditions of grate firing will usually be found to produce an ash which contains from 16 to 18 per cent combustible. The ash and slag produced in the test given above contained only a trace of combustible, less than 0.1 per cent.

The results reported in this test do not represent unusual or superimposed operating conditions, necessitating the supervision of trained technical men and unusual care in firing. It represents what may be obtained day in and day out, without extra precautions and without skilled engineers.

In making the observations, however, during the test, every precaution was taken to insure the accuracy of the results. The horsepower developed was recorded by a General Electric flow meter. This record of the water evaporated was checked by weighing the actual amount of water delivered to the boiler on automatic water-scales. The results by the two methods agreed

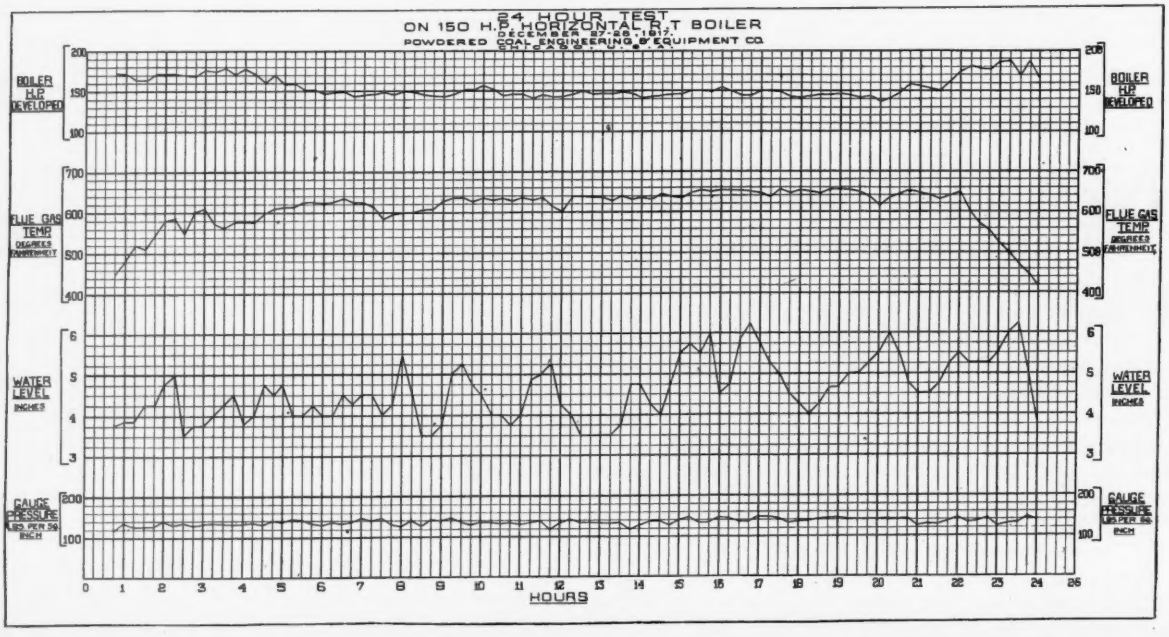

24 HOUR TEST
ON 150 H.P. HORIZONTAL B.T. BOILER
POWDERED COAL ENGINEERING & EQUIPMENT CO.
BOILER H.P. DEVELOPED
FLUE GAS TEMP. DEGREES FAHRENHEIT
WATER LEVEL INCHES
GAUGE PRESSURE LBS. PER SQ. INCH
HOURS

FIG. 2. HOURLY RESULTS OF TEST CHARTED

within a few per cent. All steam and water pipes were carefully tested for possible leaks. The percentage of CO_2 in the flue gases was recorded by a Simmance-Abady Precision Combustion Recorder. Checks were taken at intervals on grab samples analyzed in an Orsat apparatus. The temperature of the flue-gases was measured by a recently calibrated recording thermo-couple. The steam gage had been just checked up and found to read accurately.

At the end of the test and within a few minutes after the flame had been turned off under the boiler, the temperature of the furnace, as shown by a Thwing radiation pyrometer was approximately 2300 deg. F.

Maintaining Boiler Efficiency

By Thomas G. Estep, Jr.

AT NO TIME in the history of our country has the conservation and economical use of fuel been as vital as at the present time. It is not only necessary, but the patriotic duty of every fuel user to study very carefully the conditions at his plant so that he may be sure that all of the available heat energy of the fuel is being utilized.

This means that combustion conditions must be investigated with the aid of reliable instruments so that all guesswork will be eliminated. After proper conditions have been established, then it is necessary to place in the hands of the fireman such instruments as will enable him to maintain those conditions and it is also desirable that continuous records be kept so that the superintendent can check the work of the boiler room force.

In the combustion of all fuels under boilers, a certain amount of excess air is required because it is physically impossible to bring the air and fuel into intimate contact so that the theoretical quantity of air will be sufficient; but in many cases a larger amount of air is used than is necessary, which must be heated from the boiler room temperature to the temperature of the flue gases and this is waste.

The only way to determine whether the proper quantity of air is being used is to find the percentage of CO_2 in the flue gases. This is usually done by means of the Orsat apparatus, but a CO_2 indicator has recently been placed on the market which gives just as accurate results. The entire outfit is packed in a convenient, portable case, all that is necessary in addition to the instrument being a bucket of clean water.

This instrument consists of a graduated flask with a cock at each end. One end can be made to communicate with the vessel holding the absorbent solution (potassium hydroxide) and the other end can be connected to the boiler. To use the instrument, the cock between the flask and the absorbent solution is closed. By means of a syringe furnished in the case, the graduated flask is filled with gas from the boiler and that stop cock closed. Then the other cock is opened and the solution and the gas allowed to mix, shaking the instrument to accelerate the absorption of the CO_2. The potassium hydroxide is then returned to the reservoir and shut in by closing the cock. The cock at the other end is then opened under water and the water allowed to flow into the graduated flask to replace the CO_2 absorbed. The amount of water drawn in is read on the scale which is graduated to read in per cent of CO_2 directly. The whole operation requires only a few minutes and is so simple that it can be done by any fireman. The CO_2 indication will show whether or not the proper quantity of air is being used.

The next problem is to determine the conditions which will give proper combustion. There is a certain relation which exists between the thickness of the fuel bed and the difference in draft between the stack and the furnace. If the fuel bed is too thick, there will be a small difference and probably not enough air will be furnished for complete combustion. If the fuel bed is thin or has holes in it, there will be a large differential pressure and excess air will be furnished.

If a differential gage is used which will measure the differential pressure between the stack and the furnace and then CO_2 readings be taken with various differential pressures, the pressure difference which will give the best CO_2 readings for a given fuel can be determined. Then by manipulation of the damper and the fuel bed the proper conditions can be maintained, checks being frequently made with the CO_2 indicator.

Various differential draft instruments are on the market, one of which is the Ellison gage, a form of multiplying gage which admits of very close reading. It is inexpensive and easily installed. Another instrument, known as the Hydro, operates on the float principle and is made so that it both indicates and records the differential pressure, thus giving a permanent record which is valuable as it gives a check on the work of the firemen.

If a fireman is supplied with a CO_2 indicator and a differential draft instrument, there is no reason why proper combustion cannot be maintained at all times with a consequent saving in fuel.

The following figures have been received from the Signal Corps, Aviation Section, of the materials necessary for a single airplane of the more simple type, and exclusive of all the materials necessary for the engine:

Nails		4326
Screws		3377
Steel stampings		921
Forgings		798
Turnbuckles		276
Veneer	square feet	57
Wire	feet	3262
Varnish	gallons	11
Dope	do	59
Aluminum	pounds	65
Rubber	feet	34
Linen	square yards	201
Spruce	feet	244
Pine	do	58
Ash	do	31
Hickory	do	1½

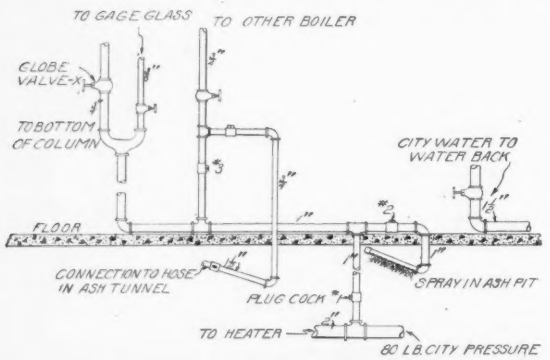
Elliott Co., of Pittsburgh, Pa., has disposed of its office building and has taken offices in the Frick Building.

The Liberty Manufacturing Co. has also removed its offices from Susquehanna St. to the Frick Building, Pittsburgh, Pa.

Ignorance or Negligence, Which?

By Jack L. Ball

ON account of the inclement weather there were not enough of the boys out to hold a meeting, so the few of us that showed up sat around the stove in the hall and swapped ideas, and the different experiences that we had had. "Pop" McGee had just related a story about a fellow who, having packed the stem of a valve in the water connection of a water column, forgot to open it after he had closed it, with the result that glass was partially filled with condensate. The boiler had been banked, to be put on the line when the peak came on. The night man thinking to blow down the boiler (h.r.t.) before he cut it in on the line, first blew out the column to get his true water level. Imagine his surprise when nothing but dry steam blew into the ashpit. He soon discovered, however, that the day man had packed the stem and forgot to open the valve. "Pop" said that he was mighty glad that in some of the states the Boiler Inspection Departments are eliminating valves between the boiler and water column, even if this fellow did find two gages of water after he got over his surprise.



DANGEROUS WATER COLUMN PIPING

"While we are speaking of water columns," spoke up the Chief, "you boys remember when I took my vacation not so long ago. Well, one evening I dropped into the boiler room of a good-sized central station, one that was supposed to be pretty modern. The boys were so friendly and good-natured, I got into a pair of overalls and started helping the engineer build a stoker fire, as they happened to be very short of help at the time. I noticed that there were two gages of water showing in the water glass. After we had gotten a good bank started on the coking plates, the engineer went up to put a new light at the steam gage. I noticed him feeling the water column, but gave it no attention. Quickly reaching the boiler room floor, he yelled:

" 'Say, mister! That column is as cold as ice!'

" 'That can't be,' I disagreed, 'there is a little steam coming out of the bleeder.'

"He killed the draft while I made a hasty inspection of the column. It was as he had said; the column was cold. I was perplexed, but lost no time in trying to find out what caused this unusual condition. By this time, the engineer had the feed pump going full speed, and that boiler certainly took water for several minutes."

The "Chief" went over to the blackboard and drew a piping arrangement like that shown in the sketch.

"This sketch shows just how that water column was piped," continued the "Chief." "The way this was connected up shows either ignorance on the part of one who installed it, or negligence by his successors. Instead of running the blowoff pipe straight to the ashpit, it was connected to the pipe that furnished water to the ashpit and for the hose in the ash tunnel. After carefully tracing up the piping, I found that the column was cold for the following reasons:

"Plug cock No. 1 was open; Plug No. 2 was closed. This allowed a pressure of 80 lb. city water pressure to be against the lower side of the globe valve marked X. After taking the bonnet off this valve, I found that it leaked so badly that the cold water pressure was enough to cause the water to rise a certain distance in the column and show in the glass because the 1¼-in. connection from boiler to column would not allow the water all to run into the boiler. You see, to blow out the column, it was necessary to close plug Nos. 1 and 3, open plug No. 2 to the spray pipe in the ashpit. The 2-in. line was an emergency connection to the heater, should anything happen to the plant's own supply. The connection to the column of the other boiler of the battery was made in the same way. This could have been conveniently connected to the 1½-in. connection to the waterback, the distance being about 2 ft. I have never determined why this stunt was 'pulled off.'

"The boiler had been emptied that day and washed, but no report except that the stoker had undergone some minor repairs, had been made the night man.

"There were no tubes lost; but I have learned since that there has been a change in the management of the plant, the manager deciding that he could not tolerate a man who would allow a piping arrangement like that to exist.

"I am wondering just how often the water tender or firemen took the trouble to blow out those columns; not very often, I'll bet, for I unearthed plug cock No. 1 under a lot of odds and ends that had been allowed to accumulate.

"These boilers carried 175 lb. steam pressure, and when a tube ruptures, even in a water-tube boiler—well, men have been known to have been scalded to death. Always meet your relief with a full account of all the repairs or changes that have been made on your shift; do not mumble some unintelligible words and hurry to get away. This is something that happens every day—maybe not intentionally. Perhaps men do not think it worth while saying anything about it; it didn't amount to much anyway. These things, little as they seem, might result disastrously.

"Can any of you boys tell me why the different inspectors allowed a condition of this kind to exist, may be for years? I can't reason it out. Were they in a hurry to get away also?"

Twenty per cent of the world's shipping has been destroyed by U-boats or is interned in neutral harbors. There is not enough left to transport all of the food Europe must have unless it is in concentrated form. The concentrated foods, those containing the greatest nourishment in the least shipping space, are beef, pork and mutton, wheat, sugar and fats.

Selecting Valves

By J. C. Hawkins

TIME WAS when one valve manufacturer made a better globe valve than anyone else, and another manufacturer made a better gate valve, and a third a better plug cock, and so on. But these days have passed, and at the present time there are many companies making valves of all kinds equally well and with a range of patterns wide enough to cover all needs within reason.

In many plants, however, it seems to be the custom to buy valves of several different makes, with the result that in order properly to take care of and renew any broken or worn out parts a large assortment of repairs is necessary; it frequently happens that a valve of the wrong type or one built for a higher or lower pressure is used, with the result that it may not stand the strain or the cost to get the desired results is greater than it should be. There is also another source of unnecessary expense where valves of several different makes are used, and that is that when trouble occurs, as breaking of the stem, stripping the packing gland nut threads, a frequent occurrence, or other similar troubles, instead of renewing the broken parts a whole new valve is necessary, and the old valve may go to the junk pile long before its time. Whereas, if one make of valve is used, the necessary parts can be supplied, not only simplifying the work of making such repairs, but also making it possible to use the old valve until worn out.

If proper valve service is to be had, the valves must be given proper attention. Worn seats and discs should be replaced or repaired, broken or bent stems renewed or straightened, loose or broken hand wheels given the proper attention, and so on through the list of parts. In most cases the valve bodies are covered, and when repairs are necessary it may be difficult to determine just what make or style the valve is without tearing off the covering, which, if the proper parts are at hand, makes repairs more expensive. The greater part of this trouble may be avoided by using valves as far as practicable of one make. If the engineer prefers Jenkins valves, he can find some type that will fit every service, and the same may be said of Lunkenheimer, Nelson, Pratt & Cady, Chapman and others of standard make. In some makes of valves it will be found that some of the parts that are most subject to wear are interchangeable in different types of the same size valve made by that company, with the result that a minimum assortment of spare parts are required to make any necessary repairs. For instance, globe valves built for 125 lb. pressure may use the same packing gland nut, stem, disc, disc holder and nut, and handwheel as one built for 175 lb. pressure, the only difference being that the body and bonnet are built heavier for the higher pressure. In selecting a valve for any given service, one built for the pressure on which it is to be used should be chosen. As an example of the wrong valve being used, there is in the writer's plant a ⅜-in. globe valve built for 250 lb. working pressure, and so stamped, used on the water line to a damper regulator where the maximum pressure is 45 lb. It was installed when the plant was erected, and possibly was the only one available at the time. The valve is seldom used, but unfortunately it is directly in front of the office door and every valve salesman that visits the chief engineer sees this valve and comments on the economy of using a 250-lb. pressure valve on 45-lb. service. The cost of the valve was double that of a valve designed for the pressure carried.

In addition to considering the pressure carried when selecting the proper valve for any given service, the service to which the valve is to be subjected should be considered. In cases where the valve is to be used infrequently, as in the instance cited above, or for temporary use on pressure not over 100 lb., the lowest-priced valve that can be purchased will give just as good service as the most expensive ones, at the same time making a considerable difference in the cost where a large number of valves are used.

For a given pressure, the same type of valve can be used on either water, steam or air, with the exception that in the case of a globe valve a different grade of disc should be used. For water pressure, a medium soft disc should be used, unless the pressure is high and the valve throttled a considerable part of the time, in which case the water passing through the restricted opening will cut the seat and cause leakage. For steam, the disc should be of a harder grade, and the discs made of monel metal are exceptionally good where the steam is throttled through the valve, as this metal is tough and resists the action of steam in wiredrawing through the restricted opening. For high-pressure or superheated steam, monel metal discs and seats are to be recommended entirely.

The Stage

By John Pierce

THIS world is but a theater where the game of life is played,
And for every human being, a part is quickly made.
The farmer and the miner, each has his separate part;
The banker in his office; the driver in his cart.

Although the stage is crowded, no one is turned away,
For everyone is needed to carry on the play.
One has the part of teacher, to teach the country's school,
Another acts the preacher—while some but act the fool.

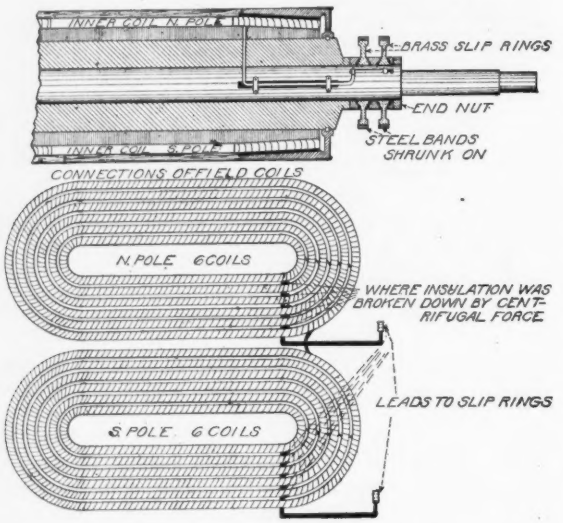
Statesmen and judges sit there to guide and check us all,
Some march to guard the banner and heed the bugle's call;
Many in trade's mad contest, journey both far and near,
But the one who turns the wheels of life is the grim glad engineer.

Forty-nine million horsepower is the figure set by one eminent authority for the capacity of stationary power plants in the United States.

Eliminating Field Coil Insulation Trouble

IT RECENTLY fell to my lot to locate and repair the faults in two alternating-current generator revolving fields. These belonged to two 469-kv.a., turbine-driven, direct-connected, horizontal, 3-phase generators, and ran at a speed of 3600 r.p.m. The connection diagram and layout of the coils and slip rings are shown in the accompanying sketch.

The first indication of trouble which had come to my attention was when one of the generators, No. 3, failed to build up voltage when the field switch was closed after starting up. The current indicated on the field ammeter was, however, about 100 amp., whereas normal exciting current at no load should have been about 20 amp. To make certain that no short existed in


INNER COIL N. POL
BRASS SLIP RINGS
END NUT
STEEL BANDS SHRUNK ON
INNER COIL S. POL
CONNECTIONS OF FIELD COILS
N. POLE 6 COILS
WHERE INSULATION WAS BROKEN DOWN BY CENTRIFUGAL FORCE
LEADS TO SLIP RINGS
S. POLE 6 COILS

FIELD COIL CONNECTIONS AND LOCATION OF BROKEN DOWN INSULATION

the cables to the slip rings, the machine was shut down and the field switch closed with the slip ring brushes raised. As no current was indicated the switch was opened and closed again with the brushes down, and this time normal no-load current was taken by the field, indicating that the trouble was not present with the machine at rest.

With the field switch still closed the generator was again started and gradually brought up to speed. The voltage built up nicely till a speed of approximately 2900 r.p.m. was reached, when the voltage suddenly dropped to zero and the exciting current jumped from 20 to 100 amp. This seemed to prove that the field winding was being shorted out by the movement of some part of the leads between the slip rings and the coils, due to the centrifugal force when the field was in motion.

The ventilating head of the generator was removed and as a careful examination of the rings and outer ends of the leads failed to reveal any likely cause of the trouble, it was decided to remove the entire field and install the spare one which was on hand. It was also desirable to put the old field in the lathe to true up the bearing surfaces and ascertain whether the shaft was perfectly straight or not. Some difficulty was experienced in removing the old field, as the coupling was just ¼ in. too large in diameter to pass through the stator frame, consequently it had to be heated with torches and drawn off. Before installing the spare field, its coupling had also to be drawn off and then forced on again after it was in position. About that time we were thinking some rather hard things about the designer who had somehow overlooked this feature of accessibility.

After the new field was lined up and put in service it worked nicely and attention was then turned to the old one, which was removed to a cool place and set up on a pair of heavy trestles. It was decided to remove the steel band on the slip ring end which covered the ends of the coils, in order to inspect the connections and condition of the leads and coils; but here again we met a stumbling block, as the band would not pass over the slip rings, these being a fraction of an inch too large in diameter. It was then decided to remove the slip rings and after much heating and careful prying and pounding they were finally gotten out of the way.

I could only account for the extreme tightness with which the rings compressed the mica on the shaft, by assuming that the sectional brass part of the ring was first put in place and the steel band shrunk on afterward. The original design of the slip rings was to make them a sectional brass affair; this proving troublesome at the factory, the steel bands had been shrunk on, thus making good slip rings, but too large to permit of slipping off the coil band over them.

With the rings and the coil band out of the way, it was then apparent that the short-circuiting of the field coils was caused by the two leads (which were insulated copper strips) having cut through the insulation on the five outer coils over which each of them passed on their way to the inner coils of the two groups. With the aid of one cell of battery, a spool of fine wire for resistance, and a milli-voltmeter, the field was tested to make certain that the above was actually the fault. The battery was connected to the field coils with the resistance in series and a milli-voltmeter reading taken across the field terminals. A small steel bar with no sharp corners was then used to pry the leads outward against the coils in the same manner that they were thrown out by centrif-

ugal force when the field was running, and a change in deflection on the milli-voltmeter was immediately noted. It was observed that each change of pressure on the steel bar, that is, the short-circuiting of a different number of coils in the field, was accompanied by a change in deflection on the milli-voltmeter.

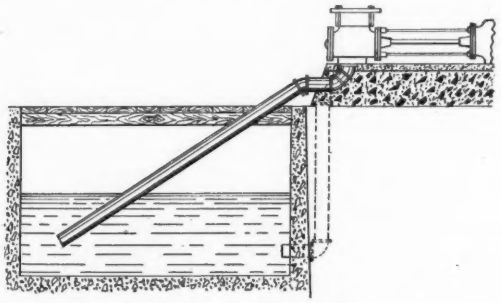
The repair to this fault was made by first carefully tapping the broken spots in the insulation of the coils and leads, and by inserting between each lead and its group of coils a piece of 1/32-in. red fiber about 1½ in. wide by 5 in. long, this being firmly shellaced and tied in place. The band was then replaced over the coil ends and the slip rings put on as carefully and tightly as possible, using new mica next to the shaft and the old mica on the sides. The field was then sent to the machine shop, where the two bearing surfaces on the shaft and the slip rings were turned up. About the time this repair was completed there was evidence of a similar fault developing in No. 2 generator, as it showed a slight increase in no-load exciting current and also some vibration, probably due to the fact that the short-circuiting action of the two leads was not equal, that is, more coils of one group were being shorted out than in the other group.

As it was desired to turn up the bearings on number 2 field, it was removed and the repaired field put in service in its place. It was found possible to repair the damaged tape and insert the extra fiber insulation in the number 2 field without the removal of either the coil band or the slip rings, which, of course, saved a lot of work. This field is now held as a spare to be used when occasion demands.

It was noted also that on the new field which was on hand when the trouble started, and which was installed in number 3 generator, that the manufacturer had discovered the weakness of the previous design and brought the two leads out on the other two spokes of the spider, so that they led directly to the two inside coils and did not have to cross the other five coils of the groups at right angles to them. W. J. S.

Change in Piping Eliminates Pump Trouble

ALL THE hot drips, returns, etc., in one small plant were brought back to a sump or receiver tank located just below the floor level from which the boiler feed



ORIGINAL AND CHANGED SUCTION PIPING ARRANGEMENT

pump picked them up and passed them through the closed heater in the boiler. While ordinarily the water in the sump tank was quite cool, a large portion of it being condensed from a condenser was at about 100 deg., frequently the pump pounded and knocked because of the collection of vapors in the suction pipe, and this was found to occur when the discharge from a number of high-pressure steam traps was entering the sump filling it with steam and a considerable quantity of hot water.

The suction was run into the tank as shown in solid lines in the sketch and it occurred to us that some of the trouble might be due to the exposure of part of the suction pipe of the steam and hot water which collected in the upper part of the tank. Therefore, at the next opportunity, the suction pipe was taken from the inside of the tank and placed as shown in dotted lines, which removed it from the steam and vapors, and also took its suction from the lower and cooler section of the tank. As a result of the change, practically no further trouble was experienced in handling the water except at times when the sump was filled with very hot returns and trap discharge, when the trouble was remedied by injecting a quantity of cold water to lower the temperature. M. A. SALLER.

Automatic Pump Controls

SEEING John A. Palmer's sketch on page 976 of the Dec. 15 issue recalls a similar arrangement which I used several years ago on a tank system. The tank was used for sinks and toilets in a factory and the cost of outside water at the time was so prohibitive that we pumped our own water. The sketch will perhaps describe the outfit better than words.

As the whole outfit was in the engine room and was always well kept, it was necessary to have an overflow pipe on the pail, as will be seen; a valve was introduced in the bottom which made easy adjustment. This outfit was in use fully 25 years ago and never gave any trouble.

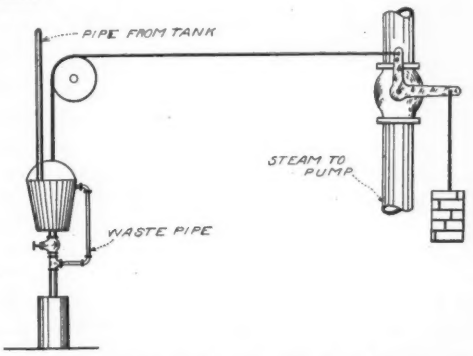


FIG. 1. STEAM VALVE OPERATED BY WATER WEIGHTED PAIL

In Fig. 2, is shown a more complicated device which I use on a belt-driven tank pump. It has worked perfectly for years and has cost nothing for repairs.

A 3-in. cylinder, made from brass pipe, is clamped to the 4-in. pipe from pump. A ½-in. globe valve with stem threads removed is inserted between cylinder and pipe. This valve is weighted for pressure desired on the line; float valves are used on different tanks and when all these float valves are close the pressure is allowed to build up to 40 lb. Then the ½-in. valve opens and lets water enter the cylinder and as a result the

piston moves upward and pulls crosshead and shifter pins to the right.

When the piston is at top the crosshead is at rest with belt on loose pulley and the trigger engaged with the hook on the crosshead. As the pressure drops the ½-in. valve seats and the piston slowly descends due to the weight on the cross tree which forces the water out of the cylinder through the slightly opened bleeder valve.

The chain from the crosshead on pump shifter to cross tree on piston rod gradually slackens until trigger is released, then belt slides on tight pulley and pump starts. It is not practical to connect the cylinder directly to the pipe (without reducing valve) I find; neither is it practical to allow the belt to slide too slowly. No springs are used in the construction and it is on the job all the time and has never asked for shorter hours or a raise. TOM THUMB.

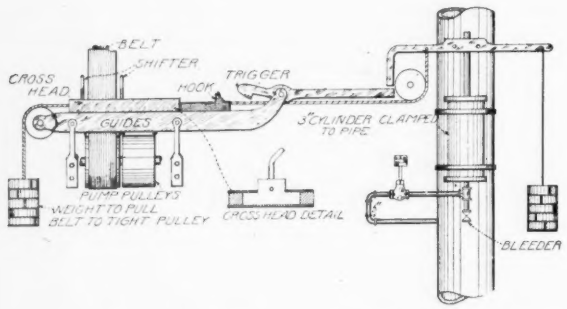


FIG. 2. PUMP BELT IS SHIFTED BY WATER OPERATED PLUNGER THROUGH MEDIUM OF TRIGGER AND GUIDES

Accumulator Used with Vertica Turbines

IN GLANCING OVER the issue of Dec. 15, I notice under "Questions" on page 978, the following:

"Describe the construction and operation of an accumulator as used on a vertical turbine." Whereas the answer is all right for a regenerator accumulator, the question evidently referred to a hydraulic accumulator.

The original installations of Curtis turbines consisted of an accumulator as part of the apparatus, and its object was to provide a secondary water pressure for the step bearing at the base of the turbine, should the pump fail.

The accumulator was nothing more nor less than a plunger elevator loaded sufficiently and with plunger of right diameter to give the necessary pressure. This accumulator was nothing new in the mechanical field, as the same apparatus had been in use for years to supply hydraulic presses.

In some cases, the accumulator was connected with a chain to the throttle valve of pump and when the accumulator's plunger had risen a certain height the throttle would close sufficiently to prevent plunger from rising more.

Perhaps a sketch may illustrate the accumulator better than my description.

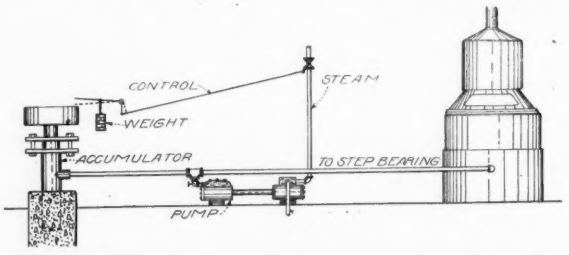
In later practice, pumps have been installed in duplicate or even triplicate with automatic control so that should one or even two pumps fail, a third would start automatically before the step became in danger of dropping.

Had the manufacturers of horizontal turbines taken the precaution to safeguard the oiling system with more pumps or incidentally an accumulator, fewer bearings would have frozen, and fewer engineers would have been looking for new positions.

I think it would be proper to distinguish one piece of apparatus from the other by calling one the hydraulic accumulator and the other the regenerating accumulator.

TOM THUMB.

I BELIEVE that W. P. misunderstood question 2 of "Boiler and Engine Questions." Instead of describing an accumulator as used on a vertical turbine, he has given a very good description of a regenerator. Although I will admit that a regenerator is sometimes called an accumulator, yet from the wording of the question I believe it to refer to the oil accumulator used in the step bearing oil system of the Curtis type of vertical turbines. This is a tube or cylinder containing a spring weighted piston. The lower end of the cylinder is directly connected to the high-pressure oil line between the pump and the oil baffle; as this part of the system is under a pressure of from 800 to 1000 lb., the piston will be forced upward against the spring. Should the oil pump fail for any reason, the spring acting upon the piston will prevent any rapid fall in pressure, and as the step bearing is generally supplied at a pressure of from 150 to 200 lb., due to the action of the oil baffle, an accumulator will maintain the pressure on the bearing for a period of 10 or 15 min., which will give the operator time in which to stop the turbine or start another pump. An accumulator also has a tendency to absorb any shock due to irregular pump action; they are generally provided with an alarm bell to warn the operator in case of pump trouble. A. C. MCHUGH.



ARRANGEMENT AND PIPING OF TURBINE ACCUMULATOR

Eliminating Scale Accumu

WE HAVE four 5 ft. 6-in. by 18-ft. horizontal return tubular boilers, each having 72 4-in. tubes. In cleaning these boilers, which is done monthly, we find much loose scale deposited at the front end of the shell.

The feed water is exceedingly hot, and is introduced at the rear end; the boilers are blown off once every 24 hr.

Located at the top 48 in. from the front end is the safety valve while 96 in. from the front end is the 5-in. main steam outlet. There is also 24 in. from the front end, a 2-in. outlet which might be used for top feed or blowoff.

The boilers are each shutdown once a month and after being left standing for three or four days, so as

to allow sufficient cooling, they are washed and cleaned. We have been using on an average 1 lb. graphite and 1 gal. of crude petroleum a month in each boiler.

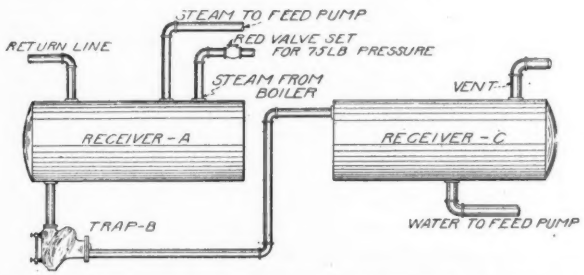
Any suggestions from the readers of Power Plant Engineering whereby I may eliminate the scale accumulations referred to above will be greatly appreciated.

W. T. McF.

Keeping Laundry Machines Dry

I HAVE HAD much trouble in taking care of the condensation, and keeping laundry machines hot and free from air. I have tried several of the trap systems but could not get results, so decided to apply a scheme of my own.

The accompanying sketch is almost self-explanatory. First, I took a standard globe valve and sawed the wheel off so it could not be opened by anyone but myself and then drilled a small hole through the disc (the holes vary from 1/16 to 7/32 in., depending on the size of the machine) and shut the valve tight and placed one of these valves on the return side of each machine. Then



ARRANGEMENT OF APPARATUS USED TO REMOVE CONDENSATE FROM LAUNDRY MACHINES

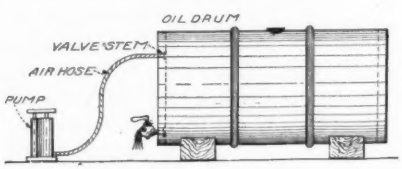
by connecting the return to one common line and connecting this to receiver (A), trap (B) will drain receiver (A) and discharge into receiver (C) from where it is removed by the feed pump.

To help circulation, I took steam from receiver (A) to run the feed pump, but as there was not enough steam passing through the small holes in the return valves to run the feed pump I connected a line direct from the boiler to receiver (A), put a reducing valve in this line and set it for 25 lb. less than the boiler pressure. This pressure being 100 lb. and that on receiver (A) 75 lb. gives a good circulation and every machine is as dry as can be expected.

CHAS. L. BEARD.

Removing Cylinder Oil

AS A RULE, and especially when cold, the draining of cylinder oil out of a drum or barrel is quite a slow process. To hasten matters, therefore, I took the valve stem off the inner tube of an automobile tire and after drilling a ½-in. hole through the cast-iron cap of the drum, I attached the valve stem as shown by means of a leather washer on the inside and a locknut on the outside. I first put the washer on the valve stem and then passed it through the hole, the leather accommodating itself so as to enter the hole readily.



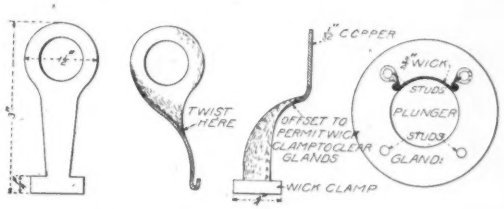
METHOD EMPLOYED TO REMOVE CYLINDER OIL FROM DRUM

A short length of rubber hose was then used to connect the valve stem with the bicycle pump, by means of which I was able to increase the pressure of the air within the drum sufficiently to cause a free flow of the oil.

E. G. C.

A Novel Plunger Oiler

THE 10-IN. PLUNGERS on an outside packed pump in my case developed an annoying squeak. After trying all ordinary methods of stopping the noise, and receiving but temporary relief, I employed the wick oiler shown



WICK HOLDERS AND METHOD OF APPLYING THEM

in the enclosed sketch; a few drops of engine oil applied to the wick daily has entirely eliminated the squeak.

A. S.

Work Rack for Boilers

SHOWN HEREWITH are two sketches showing how a rack for working around boilers such as the Heine and Edge Moor types, may readily be made out of a number of lengths of piping, eight tees, four elbows and two flanges, all of standard weight. This stand, which is comparatively light and strong, can, when not in use, be stood up against a wall and in that way occupy but very little room.

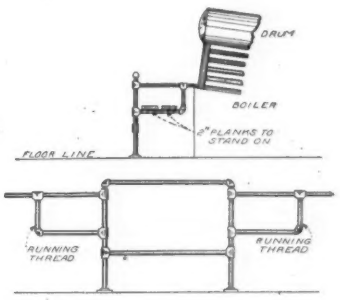


FIG. 1. METHOD OF USING RACK IN CONNECTION WITH HEINE BOILERS

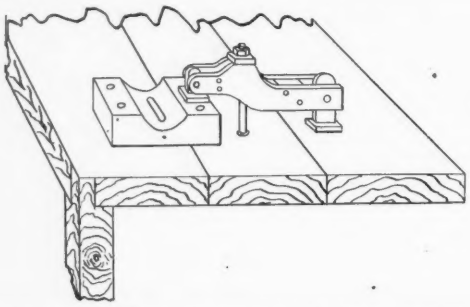
FIG. 2. RACK WITH SIDES SWUNG OPEN, THUS OCCUPYING LITTLE ROOM WHEN NOT IN USE

At first, it would appear as if two unions might be required in the construction of this rack; but by cutting a running thread upon one end of the lower pipe, the joint can be made by screwing the long thread way in and then backing into the opposite fitting. This makes a strong joint; but, due to the leakage bound to result, it is not one which might be used in piping carrying fluids.

C. E. ALDRICH.

Bench Clamp or Holdfast

FROM A FEW PIECES of scrap stock the bench clamp, or holdfast, as shown in the accompanying sketch, was constructed. It is an extremely useful tool on the bench. The floating feet permit its being readily used for various heights of work. Work too bulky for the ordinary

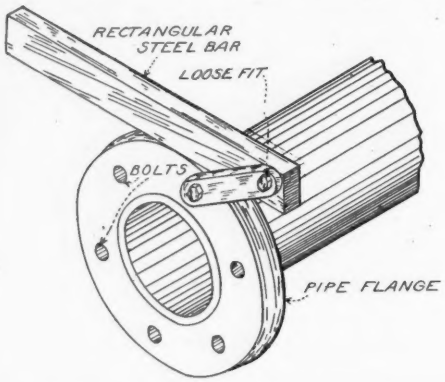


A READILY CONSTRUCTED BENCH CLAMP OR HOLDFAST

vise is easily held fast by this tool. The idea is one that the writer picked up during his visits to the other fellow's plant, and proved so good that he considers it worth passing along. C. H. WILLEY.

Wrench for Pipe Flange

IN THE accompanying sketch is shown a form of wrench I have used for putting on and removing flanges



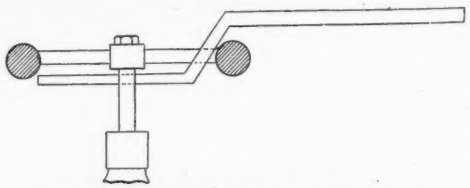
EASILY MADE PIPE FLANGE WRENCH

from pipes. It is easily made, never slips and can be used on almost any type and size of pipe flange.

C. C. SPREEN.

Wrench for Opening Tight Valves

IN MAKING our regular early fall inspection of our heating system with a view to overhauling it and putting it in good shape for the winter season, we encountered quite a number of the valves which were difficult to turn open because they had rusted or "frozen" shut. Many of these valves could not be opened by hand, and the position of some was such that a large wrench could not be used. Since the heating system covered several buildings and required the inspection and opening of a large number of valves, we rigged up a simple tool from a piece of old steel rod, as shown herewith. This rod could be inserted in the hand wheel of practically all

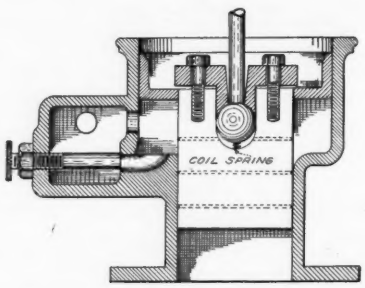


METHOD OF USING WRENCH ON VALVES

the valves, even the small ones, and the increased leverage afforded made it very easy to force open even the most obstinate valves. The tool proved so useful in this service that we made up a large size and a small size for our regular tool kit. M. A. SALLER.

Eliminating Lost Motion in Dashpot

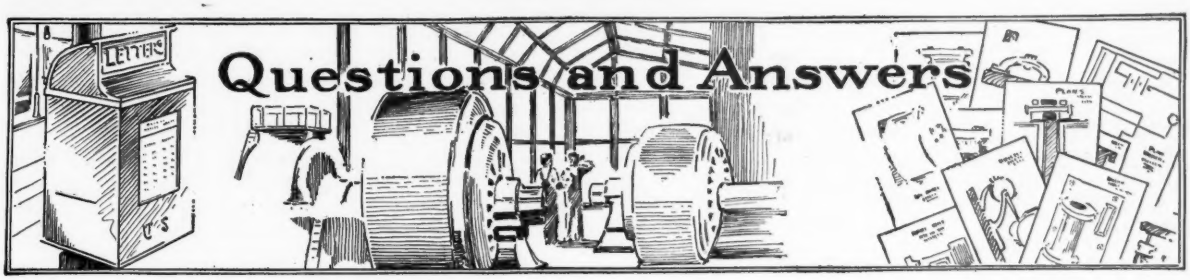
THE SOCKET joint in the plunger of the dashpot of a Corliss engine being badly worn and causing much trouble, I remedied matters as shown in the accompany-



COIL SPRING PLACED BELOW BALL OF ROD ELIMINATED ALL LOST MOTION

ing illustration. Being directly under the ball of the rod, the coil spring took up all lost motion which formerly existed. E. G. CARLSON.

WHERE THERE is war, food cannot be produced. A steel plow helps production, but steel is not a good cultivator when it breaks the land in the form of a shell. That has been shown in France, Italy, Belgium and all of the other countries shattered by battle. But a nation can be at war and still maintain production, if the battle lines do not encroach on the farms. That has been shown in Germany and is being shown in the United States. We have been charged with the tremendous task of feeding our associates in this war, of maintaining production on a scale that will meet our actual needs and still leave enough to fill the gap between Europe's production and consumption. The only solution is to reduce our own use of the foods most needed abroad. We must employ substitutes for beef, pork and mutton, wheat, sugar and fats. This war is as much ours as it is Europe's and there is no reason why we should ask Europe to bear all of the sacrifices and deprivations.



Commutator Trouble

I HAVE BEEN HAVING considerable trouble with a small exciter commutator sparking badly.

We have taken it out twice and had it turned down, but the sparking begins again within a few days and the commutator becomes thick with smudge.

I have tried to talk the other men into cutting down the mica, as I believe that has been the trouble all the time.

At first, it would help out to sandpaper the commutator; but it soon gets beyond that. M. E. W.

A. Without knowing more of the conditions under which the exciter operates, it is difficult for us to advance any definite opinion as to the cause of the trouble and as to how it may be eliminated.

It occurs to us that the trouble may be due to an overload on your machine, in which event it is, of course, almost impossible to prevent sparking without reducing the load. Then again, the trouble may be due to high mica, in which event the remedy would consist, as you suggest, of undercutting this mica, or you may find that the brushes are either not in their neutral position or that some of the sets are out of alinement.

You might try shifting the brush holder and in this way determine the position at which the least sparking occurs. If, however, this does not remedy the trouble, determine whether the brushes are evenly spaced around the commutator. This may be done by measuring from the center of one set of brushes to the center of the following set. In case you find any considerable difference in these measurements, it will, of course, be necessary to shift the various sets until they are evenly spaced about the commutator.

On the other hand, all your trouble may be due to the use of brushes not suitable for your particular kind of service. If you will turn to page 541 of the July 1, 1917, issue of Practical Engineer, you will find an article entitled "Dynamo Brushes," from which we are sure you will be able to obtain much information relative to their characteristics and application. O. H. H.

Thawing Frozen Water Pipes

I HAVE a ¾-in. 100-ft. long water pipe which is frozen. How can I connect up to 110-v. alternating-current electric circuit to thaw out this pipe and still not do any more digging than is absolutely necessary.

V. V. S.

A. For the length of pipe that you have, 110 v. is rather high. We doubt if you can use it direct.

It will be best to connect a step-down transformer so as to get a voltage of not over 50 or 60. Then connect current from one terminal of this transformer to one end of the system, and the other terminal to the other end.

It would be well to have a regulating resistance, either in the primary or secondary of the step-down, so that you can control the amount of current being sent through the pipe. After you have these connections, turn on the "juice" and let it work.

The whole proposition is to get sufficient heating of the pipe, by sending electric current through it, so that the ice will be thawed, and the only precaution is, that you do not take sufficient current to overload your transformer. Of course, the heavier current you send through, the quicker will the thawing out process take place.

A. L. R.

The Uniflow Engine; Mechanics Questions

EXPLAIN briefly the working of a uniflow engine.

2. Give formula and explain how to find the holding power of the thread on the bonnet of a valve. What factor of safety is usually allowed, and how is the safe working pressure determined? Also formula for pipe and bolt threads.

3. What is the modulus of elasticity of steel or any metal, and how is it found?

4. What is the modulus of rupture?

R. F. B.

BRIEFLY STATED, in the uniflow engine the steam enters the cylinders at the ends, after passing through steam jacketed heads; and after cutoff and expansion have taken place, the steam is exhausted through ports arranged around the center of the cylinder, which are uncovered by the piston at the end of the stroke. The steam has consequently a flow in but one direction, hence the derivation of the phrase "unidirectional flow."

The uniflow principle has for its object the elimination of initial condensation, one of the greatest losses in reciprocating engines.

2. We presume that what you desire is a formula which may be used to calculate the safe load which a threaded bolt may carry. Let P = load on the bolt, d_1 = diameter at root of thread, a = area of cross section at root of thread and Sw = safe working stress in lb. per sq. in., we can say (for tension).

$$P = aSw = \frac{\pi d_1^2 \, Sw}{4}$$

For various stresses Sw may be taken as about 5000 or 6000 lb; usually it is taken as 4000 or 5000 lb.

We do not know of any formula applicable to pipe threads as pipes are generally used only to conduct fluids and not for the transmission of loads.

3. The modulus of elasticity is defined as the load per unit of section divided by the extension per unit of length.

Let P be the applied load, k the sectional area of the piece, l the length of the part extended, A the amount of the extension, and E the modulus of elasticity. Then $P \div k =$ the load on a unit of section; $A \div l =$ the elongation of a unit of length.

$$E = \frac{P}{k} \div \frac{A}{l} = \frac{Pl}{kA}$$

Within the elastic limit, when the deformations are proportional to the stresses, the coefficient of elasticity is constant, but beyond the elastic limit it decreases rapidly.

The modulus of elasticity of steel varies from 28,000,000 to 32,000,000.

The modulus of rupture is sometimes defined as the strain at the instant of rupture upon a unit of the section which is most remote from the neutral axis on the side which first ruptures.

This definition, however, is based upon a theory which is yet in dispute among authentics, and it is better to define it as a numerical value, or experimental constant, found by the application of this formula:

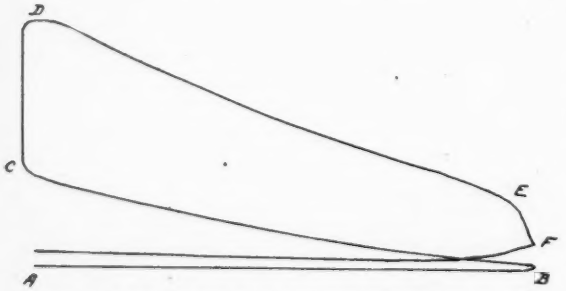
$$R = \frac{3\,P\,l}{2\,b\,d^2}$$

Where R is the modulus of rupture.
P is the breaking load in pounds.
l is the length in inches.
d is the depth in inches.
b is the breadth in inches.

Two- and Four-Cycle Gas Engines

PLEASE EXPLAIN to me the difference between two-, three- and four-cycle gas engines. C. C. W.

A. Relative to the operation of the three-cycle gas engine, we wish to state that we have never heard of this type of engine, there being only the two-cycle and the four-cycle engines. In the two-cycle, single-acting engine an explosion takes place with every revolution, or with each forward stroke of the piston. Referring to the accompanying diagram and beginning at E, when the exhaust port begins to open to allow the burned gases to escape, the pressure drops rapidly to F before the end of the stroke is reached. An inlet port opens admitting a mixture of gas and air from the reservoir in which it has been compressed. This mixture being under pressure assists in driving the burned gases out through the exhaust port. The inlet port and the exhaust port close early in the return stroke, and during the remainder of the stroke B C, the mixture, which may include some of the burned gas, is compressed and the ignition takes place at C. In one form of the two-cycle engine only compressed air is admitted while the exhaust port is open —fuel gas being admitted under pressure after the exhaust port is closed. By this means a greater proportion of the burned gases are swept out of the cylinder.



TYPICAL FOUR-CYCLE GAS ENGINE INDICATOR CARD

In the four-cycle engine one ignition of gas takes place in one end of the cylinder every two revolutions of the flywheel, or every two double strokes. The following sequence of operation takes place during four consecutive strokes:

(a) Inspiration of a mixture of gas and air during an entire stroke.

(b) Compression during the second (return) stroke.

(c) Ignition at or near the dead point, and expansion during the third stroke.

(d) Expulsion of the burned gas during the fourth (return) stroke.

Strictly speaking, four cycle should be called four-stroke cycle, but the term "four cycle" is usually used in the trade. O. H. H.

Concrete Boiler Setting Walls

WE HAVE two 125-hp. boilers 18 ft. long and 72 in. in diameter which are at present resting in the setting walls, an arrangement which, due to a recently enacted state law, is now prohibited.

What do you think of building the outside wall of reinforced concrete? Would you advise building the center wall of the same material and of what dimensions would you make these walls?

With what would you line these walls?

C. M. B.

A. As to the setting of boilers, we believe that reinforced concrete for the outside walls would be very satisfactory. We have not information as to any construction of this kind that has been used, but see no reason why it should not be just as durable and as lasting as the concrete chimney.

We do not believe it would be wise to use this for the inside walls, as the heat to which these walls are subjected is considerably greater than that in the chimney. The temperature of the furnace is some 2000 deg. F., while that of the chimney is seldom over 500 or 600 deg. F. The outside wall of reinforced concrete, with an inside wall of brick and a lining of fire-brick, should work very satisfactorily.

Of course, for reinforcing you should use some of the forms of twisted or bent iron rod ordinarily used for such work. A straight iron rod does not get a good grip on the wall. The dimensions would be practically the same as for brick—probably using for the vertical reinforcement a ¾-in. rod, spaced about 15 in. centers, and for the horizontal reinforcement, the same kind of rod wired firmly to the vertical reinforcement and spaced vertically 16 in. We believe this should hold without any trouble.

You understand, of course, that the concrete should be mixed in batches large enough so that a complete side wall can be placed and rammed into the forms at one filling, or, at any rate, without time for the concrete to set between batches, otherwise you will have a crack between the surfaces where one batch was put in and the next one.

The forms for the outside wall should be put in place, these walls filled and rammed, and then allowed to set for some 48 hr. before the mold is taken off. After this, the forms may be removed and the inside brick laid up. It would be well to put in cross reinforcements of bent rods fastened in the concrete, and extending out to catch into the inside brick walls, spaced, at say, 24 in. on centers vertically and horizontally. A. L. R.

Water Horsepower of Pumps

I HAVE a 6 by 8-in. triplex power pump running 30 r.p.m., and supplying water for humidifiers, working against a pressure of 140 lb. I wish to drive it with a motor. How many horsepower would it take?

E. E. A.

A. The theoretical horsepower required to raise water to a given height may be determined by means of the following formula:

$$\frac{\text{Volume in cu. ft. per min. x pressure per sq. ft.}}{33{,}000}$$

As the pump you refer to has 3 plungers, each with a diameter of 6 in. and an 8-in. stroke, and working at 30 strokes per min., assuming this a single-acting unit.

$$[(6^2 \times 0.7854) \times 8 \times 3 \times 30]$$

or 20,354 cu. in. of water are delivered per min. This is equivalent to 11.7 cu. ft.

The pressure per sq. in. is, as you state, 140 lb., so that for 1 sq. ft. it will be 140 times 144, or 20,160 lb.

Substituting the values thus found, in the above formula, we have,

$$\frac{117 \times 20{,}160}{33{,}000} = \frac{235{,}872}{33{,}000} = 7.14 \text{ hp.}$$

Truck Motor for Stationary Work

CAN AN ENGINE taken from a motor truck be made to run with governor so as to keep speed constant with change of load? Without a governor it does not work very well. The speed is either too slow or too fast. It is a gasoline motor. J. V. C.

A. Unquestionably, the engine from the motor truck could be equipped with a governor operating on the throttle which is moved by the accelerator, when the engine is used on the truck. An ordinary flyball governor with link mechanism connected with the throttle valve would probably do the work; but, of course, it would be some trick to get this adjusted so that it would handle the load right.

Alternating-Current Generator Problem

WE HAVE an alternating-current generator rated as follows: kw., 150; speed, 600; p.f., 80; amp., 180. It has a belted exciter, driven from our steam engine, but so connected that it can be driven as a motor by our oil engines to help the steam engine.

The question I would like answered is this: Does this generator when driven as a motor run in synchronism with the driving generator? What current should this motor take; that is, will it do 150 kw. on 180 amp. and how should the exciting current be regulated to get best results? This motor, when carrying 100 kw. takes about 175 amp. Is this due to the field current not being regulated properly? W. E. S.

A. As we understand the layout, you have an alternating-current generator of 150 kw. rating which is also connected to other generators operated by oil engines, and which can be used interchangeably as a generator or a motor.

If, therefore, we are correct in our assumption, this machine necessarily would have to be in synchronism with the generators connected with your oil engine whenever it operates as a motor, and when, if it is capable of delivering 150 kw. as a generator, it naturally would have to consume about that same amount of current or electric energy when operating as a motor.

Thus, the amount of current which this machine will take when operating as a motor depends entirely upon the degree of field excitation employed, which may be regulated by means of the field rheostat or the exciter rheostat, or both.

We would suggest that for the highest degrees of economy the motor be operated with the power factor as near unity as possible.

The fact that the machine when carrying 100 kw. takes about 175 amp., is, as you have presumed, due to the field current not being regulated properly.

More Power with Two Eccentrics

THERE HAVE BEEN a number of articles appearing on single and double eccentric valve gears and as to which allows an engine to develop the most power.

If we consider just why the double eccentric is displacing the single eccentric or Corliss engines, this question may be more clearly understood.

When a single eccentric is used or a Corliss engine, it must be advanced at an angle greater than 90 deg. ahead of the crank. This is necessary to give a sufficient amount of lead, which means an early opening and closing of all valves in relation to the moving piston. The exhaust valves require more lead than the steam valves so as to allow sufficient compression to take place at the end of each stroke.

As the releasing gear can not act upon the steam valves after the eccentric has passed its extreme throw, thus the effects of advancing the eccentric more than 90 deg. would hasten cutoff and limit its range to less than one-half of full stroke of the piston.

For instance, an engine is heavily loaded and release does not take place during the first, say a little more than three-eighths of the stroke, the eccentric has then passed its extreme throw and the valves are left engaged (or hooked up) and are out of control of the governor and are then controlled by the action of the eccentric. This would allow steam at the end of each stroke to blow through from the steam chest to the exhaust line. This would certainly not be a very economical running condition and would be very impractical.

Range of cutoff can be increased and controlled to a greater extent by the use of two eccentrics and two wristplates.

The exhaust eccentric can be set to the proper advance to suit the running condition of the engine, without affecting the steam valves. The steam eccentric can be set less than 90 deg. in advance of the crank. For ordinary running with heavy loads, I would advise an advance of about 81 deg., which would give a range of cutoff up to about 7/10 of full stroke. This would in turn allow ample time for the closing of exhaust valve before the admission of the steam.

A conclusion from the foregoing is that a Corliss engine with a double eccentric has a larger range of cutoff and will deliver more power in an economical way than an engine of the same dimensions with a single eccentric. F. E. Bacon.

Referring to N. Ewing's query on page 105 of the Jan. 15 issue, I presume that he of course understands that a common plain slide valve of old vintage must needs have a point of cutoff, even though it be 5/8, 3/4, or even 7/8 of the stroke and when the governor of a single eccentric Corliss engine is hugging the safety pin or cam, it is as the old time slide valve.

Authorities, when they explain fully, say that the single eccentric Corliss engine is under control of the governor; perhaps one-half stroke.

When the direction of valve travel reverses (governor on the pin), the steam valve in operation starts to close, and the two parts of cutoff mechanism, that is, latch and trip cam, get farther and farther apart, making a releasing cutoff impossible, yet allowing a permanent cutoff of perhaps 7/8, as the valve covers port.

When Mr. Ewing starts his single eccentric Corliss engine (provided he operates this type) he will observe that releasing gear is inoperative, yet the cutoff must take place at some part of stroke just the same.

The amount of lead and lap on the steam valves will determine this cutoff just like a slide valve; but with the modern two-eccentric Corliss, the releasing mechanism will be tripped even on starting stroke as governor controls cutoff from zero to practically 3/4 stroke.

Indicator cards ofttimes show a cutoff as long as 7/8 on two-eccentric Corliss engines.

The releasing gear unhooks before this point is reached, but the length of time necessary for the valve to close may possibly carry the piston some little distance, showing a late cutoff on the card which to the novice might seem a false reading, yet which would be perfectly true.

A number of years ago, a large Corliss engine was repaired and the cutoffs were adjusted by blocking the governor to a height sufficient to release valves at about twenty inches of the stroke.

The engine was turned over slowly with a turning gear and cutoffs were finally declared uniform.

The governor was raised to the limit and the valves pronounced O. K.

Steam was turned on and the engine put in operation, but the indicator cards were unsatisfactory.

Although the load was constant there was a variation of 12 lb. in the mean effective pressure between head and crank ends.

When it was possible to stop the engine, the governor was blocked as before and the point of cutoff noted by slowly turning as before.

The release was practically the same at both ends, yet when the engine was in operation the mean effective pressure was decidedly unbalanced. The master mechanic wanted the chief to adjust the governor rods so that the mean effective pressure would balance, but the chief was not satisfied to do this until he looked about a little. He discovered that one dashpot was decidedly slow in operation, which made a longer cutoff on that end, although the release was practically the same.

This proved to me that the dashpot has a lot to do with the points of cutoff. Tom Thumb.

The fundamental principles of nearly, if not all, valve gears are the same; it is only in the specific application that differences occur. A man who understands the common slide valve, and the relation that lap, lead, port opening, valve travel, etc., bear to one another, can apply that same understanding to the Corliss gear. The mechanical construction being different necessitates a difference in details when valve setting, or when making adjustments of any of the valve gear parts.

Now, with a single eccentric Corliss engine, the eccentric must be set with angular advance, just the same relatively as with a single eccentric slide-valve engine where the valve is given lap and lead. The four valves of a Corliss engine represent the four edges of the flat slide valve, namely, two steam edges, and two exhaust edges. It has been found from experiment, and learned by experience, that in order to have the steam and exhaust events occur as they should, the eccentric must have angular advance. Having angular advance, the eccentric must reach the end of its movement in a straight line direction, and also start to make its return movement.

The Corliss gear is a detachable cutoff gear. In single eccentric engines it is so designed that the latest cutoff—by the hook being detached from the valve arm—occurs at or near half stroke; this is so, because of the angular advance of the eccentric. In other words, if the hook is to be detached at all (by the action of the governor of course), it must occur at or about half stroke of the engine piston.

Now suppose the load on the engine is such that the governor comes down too low to cause the hook to become detached, then the valves are closed by the action of the eccentric—through the various connecting links, wristplates, rocker arms, etc.—just as though the gear were not a detachable gear, but a positive or rigidly connected gear. Under this condition, the dashpots do not close the valves because the hooks did not release them in time because the load caused the governor to come down too low, and also because the eccentric reached the end of its straight line movement (before referred to) at such a time in relation to the piston stroke, that the return movement of the eccentric occurred before cutoff could occur by the dashpots closing the valves as originally intended.

Just as the ordinary range of cutoff (up to about 1/2 stroke) occurs, by the hook releasing the valve arm and permitting the dashpots to close the valves quickly, just so in a similar manner will a longer range of cutoff

occur (about ⅞ stroke) when the valves are closed directly by the eccentric, when the hooks do not release the valves, cutoff, as late as it is, does occur, but not sharply enough, as is the case when the dashpots close the valves; the action of the eccentric cannot close the valves as quickly as can the dashpots.

In order to overcome the defects and objections before referred to, the double eccentric engine came into being. One eccentric actuates the two steam valves, the other, the two exhaust valves. The exhaust valves eccentric is set just the same as the eccentric is in a single eccentric engine. Where the difference comes in, and where the advantage occurs, is in having a steam valve's eccentric that can be set with negative angular advance; that is, it is set behind the crank a few degrees, instead of before the crank, as in the case of a single eccentric. Thus, the eccentric reaches the extreme end of its straight line movement later than the crank does of its straight line movement so the return movement of the eccentric does not occur early enough to prevent the hooks releasing the valves late in the stroke of the piston. In other words, cutoff can occur—by the valves being released from the hooks—quite late in the stroke, thus gaining that sharp cut given by the dashpots, which cannot be obtained by closing the valves by the action of the eccentric alone. With double eccentrics, you get a long range of sharp cutoff, to carry overloads, with a single eccentric, you get a long range, with slow cutoff to carry overloads, and therefore, more steam is consumed with single eccentric engines to carry a given overload than is required for a double eccentric engine for the same conditions. CHAS. J. MASON.

Relocating Wristplate Marks

A FEW WORDS to assist E. B. P., whose letter appears on page 105 of the Jan. issue; I am using his illustration, with a few additional lines thereon.

The principles involved are the same as for the usual horizontal valve gear on Corliss engines. The purpose of the center lines, ab, cd, ef, and gh, will, I think, be clear. First, it is necessary to obtain the correct lengths of the reach rods which I have marked respectively, A and B. To do this, place the line of throw of the eccentric coincident with the line gh. This places the eccentric at mid travel, so to speak. Next, adjust reach rod B so that the center line, cd, of the rocker arm will be parallel with the line, ef; then adjust the reach rod, A, so that the center line of the wristplate, AB, will be parallel with both cd and ef. There will be a slight error, owing to the angularity of the eccentric rod, which, of course, is understood, but which is not taken notice of in actual practice.

Next, place the eccentric at the extreme of its throw or line ef, toward f, and mark the wristplate, which will be in its corresponding rotative throw. Then move the eccentric to its other extreme throw, toward e, and again mark the wristplate, which will be in its corresponding extreme throw. The center mark can then be obtained from the mid distance between the marks obtained. Possibly the reach rods are not easily adjustable, and in that case they are likely the correct length, so doing away with that part of the operation.

A little time and thought spent upon the foregoing will probably make each of these matters clear to those interested. CHARLES J. MASON.

IN ANSWER to E. B. P.'s request, I would adjust all rod bearings to a close working fit, then tram engine for centers. Place engine on bottom center. With a level and dividers (set to ½ the diameter of the shaft) get the top center of shaft as illustrated at B. From this mark measure a distance equal to 22 deg. on the circumference of the shaft, as at 1 in Fig. 2. Then with a steel tape measure around the shaft and mark points 2, 3 and 4. Now make a mark on the high side of the eccentric.

With a straight valve gear, the eccentric is placed 90 deg. ahead of crank at C, with an indirect rocker. It will be 90 deg. back of it at D with the eccentric rod at an angle of 68 deg. (as illustrated) from the center line of the engine, the eccentric will be placed at 68 deg. farther back, or 158 deg. behind, as at E. Now with eccentric at E, adjust eccentric and reach rods until wristplate and rocker arm are horizontal, which may be

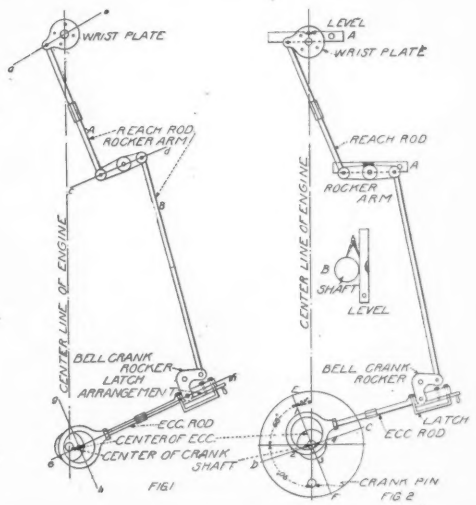


FIG. 1. METHOD EMPLOYED BY CHARLES J. MASON TO RELOCATE WRISTPLATE MARKS ON VERTICAL ENGINES
FIG. 2. L. L. RINGLE'S METHOD OF SETTING ECCENTRIC ON VERTICAL ENGINES

done with a level by placing the bottom edge at the center of the pins, and making it level, as at A, A, illustration. Then mark wristplate hub and support; that will be the center mark. Turn eccentric to F, and note whether marks are together, then turn to C, and mark far end of travel, also at D, and note whether marks are equal distance from center mark; if so, place eccentric again at E and proceed in the usual manner to set the valves, giving them the required amount of lap.

Then, with both dashpots hooked on, take a small chisel and place about half on the rockers and half on the bonnets, make a mark, then advance the eccentric to the required amount of lead and mark the location of the eccentric. All rods should be marked so that if they should from any cause get moved they can be set back to their place. With these marks, when anything gets out of time just place wristplate on center (with both pots hooked on) and you can at once locate the trouble. L. L. RINGLE.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.
(Established over 22 years.)
Formerly PRACTICAL ENGINEER.
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Why Is the Post Office?

Primarily, what is the purpose of the Postal Service? This involves the larger question, what is the purpose of any department of the government?

Aside from purely governing activities such as taxation, repression of crime, protection of citizens and the country against violence, the only reason for a department is to serve the people of the country better than a private organization can. Farming can go on without the Department of Agriculture; but the department can experiment and gather information and assist the agricultural interests better than any private or co-operative effort. It is wise to do this, even though it is an expense to the nation.

Business and trade will go on without the Department of Commerce; but that department is doing many things to help business, both domestic and foreign that would be done less effectively or not at all, if the department did not exist. And so with every department or bureau that has to do with the affairs of the people of the country. The Post Office Department is no exception.

Mail could be handled by private organizations, but it would be a long step backward if this were done, and nobody would wish to see it. The Postal Service is a great public convenience, was intended as such, regardless of the fact that it might not pay expenses. It has a better reason for being than other service departments, as it serves all classes, business, agriculture, manufacturing, alike.

And one great function has been to assist in education by serving the readers of periodicals. A low rate of postage was established with this end in view. It has done what was expected, because readers have had the full benefit of that rate in the form of low subscription rates to magazines and business papers. The great advance in selling by means of advertising has enabled publishers to give readers a service and value in the periodicals that otherwise would have been impossible, and this benefit has come, not because of the low postage rate on periodicals, but because the power of advertising has been recognized by the business and manufacturing world.

In the last Congress, a small coterie of men in the House jammed through an amendment to the revenue bill without opportunity for discussion, hearings or explanation, under the threat of holding up the whole bill indefinitely, unless their amendment was admitted. This was done after the Senate Committee, giving careful consideration to the matter, had rejected a similar and less drastic provision.

That this was not intended as an emergency revenue measure is evident from the fact that it does not become completely effective until 1920, and also from a later admission in the Postmaster's annual report that it is a permanent adjustment of postal rates, although increases other than those on periodicals are regarded only as emergency measures for war revenue.

The new and complicated zone system raises rates from 50 to 900 per cent, and divides the country into eight zones, with increasing penalty in each zone for living at a distance from the city of publication of your magazine.

This rate is 8 to 40 times higher than the present rate in Canada. It is much higher than is charged by express companies for carrying farm produce over the same distances, and this produce must be picked up and delivered as separate packages with liability for loss or damage, while the periodicals are delivered to the post office, sacked and labeled, ready for sending out.

"Subsidy" is a pet term of those who have advocated these tremendous increases. But to whom? The low rates established in 1885 were *intended* to help readers in *all* parts of the country to an education in art, literature, science and business. That has been the effect. It has been a service to the people, just as the work of the Department of Agriculture is a service to the farmers, and that of the Department of Commerce to business men.

The zone system, and the enormous increase in rates means not only a withdrawal of service, but a penalty on those who are giving their efforts to develop the resources of the newly settled portions of the country.

Every commission that has ever investigated postal matters has denounced the zone system as pernicious and impracticable, and this view was endorsed by Woodrow Wilson before he became President.

We had zone rates on letters in 1846, but Abraham Lincoln, seeing that this was a means of promoting sectionalism, secured the enactment of a flat rate on letters to all parts of the United States. Now, in the form of a rider, an enactment which could not have secured a favorable vote on its own merits, has been jammed through on the back of urgent revenue legislation. It is designed to, and it will, greatly increase the cost of periodicals to readers, and will divide the thought of the country along sectional lines. It is as unreasonable as a zone rate on letters; it is a curtailing of the *service* to the people for which the Post Office is maintained.

The only way that these evils can be avoided is by repeal of the vicious postal amendment rider. Senator Smoot has introduced a bill for this purpose, and it deserves active support from every citizen who believes in education and progress of the people of the country and in national unity as against sectionalism. Personal letters to Senators and Congressmen, protesting against the zone system and advocating the repeal of the amendment are the means to secure the continuance of national service which the Post Office should give to all, regardless of their occupation or place of residence.

Questions Suggesting Improvements for Your Plant

Are your furnaces operated to secure complete combustion or highest efficiency? What is the difference? How do you determine when your combustion conditions are being maintained as you desire them?

What provision have you made in your plant to prevent a flywheel explosion? What minor accident or combination of circumstances may occur in your plant that might cause an engine to run away and what protection is provided?

Do you know whether or not the expansion of steam in your compound engine is carried out from start to finish closely along the isothermal curve? How much power are you losing between high and low pressure cylinders?

Are you making the best use of modern, rapid methods and means for performing calculations in your power plant work such as tables, charts and slide rule?

Can you make a transformer to ring bells for signal work about the plant?

With main generating unit in your plant suddenly put out of order, how do you supply light to prevent personal injury or make necessary repairs?

How do the water temperature conditions of your ice making plant affect the capacity, and how much difference does a change of, say, 5 deg. in cooling water make?

What is your estimate of the gain in efficiency that could be secured with your boiler if it burned pulverized coal?

Have you estimated the cost of heat losses due to radiation from the bare steam pipes in your plant? Using the charts, this is a short job.

Have you read this issue with sufficient thoroughness to give your plant full benefit of the information contained in its pages? Every improvement made upon your suggestion makes you a bigger man and increases your reputation.

THE BUREAU OF MINES, Department of the Interior, recently asked the advice of a number of prominent fuel engineers throughout the country as to the best way to conserve in the use of coal during the period of the war. Martin A. Rooney, of Detroit, Mich., has the following to say:

In every trainload of coal laboriously hauled from the mines to our coal bins one carload out of every five is going nowhere and worse. In a train of 40 cars the last 8 are dead load that might better have been left in the bowels of the earth.

And it is shamelessly and needlessly wasted. Instruments and machinery for getting out all of the heat there is in it are not nearly so complicated nor expensive as the cash register which you use to keep tab on your cash receipts or the truck which you operate to clip a few cents off of your delivery costs.

Carbon dioxide, temperature and draft are easier subjects to comprehend than bank discount or freight rates.

The moral is, Mr. Coal User, get busy and learn what they are and how to use them. The time is coming when the government is going to limit the amount of our coal that is dumped down your chute and in the name of fairness, when we must deny fuel to some manufacturer, let it be to him who cannot show that he is going to use it efficiently. In the name of fairness to the miner who digs it, in fairness to the heavily burdened railroad which transports it, in fairness to a number of our people whose very existence and whose future happiness depend absolutely on the use we make of this most precious of our resources, let us make efficiency the criterion to judge by when we come to determine which shall survive.

And in fairness to the manufacturer who is patriotically operating his properties at nearly to the breaking speed and who is giving up a large part of his profits for the general good, let the government show him how to conserve this most important of his raw materials.

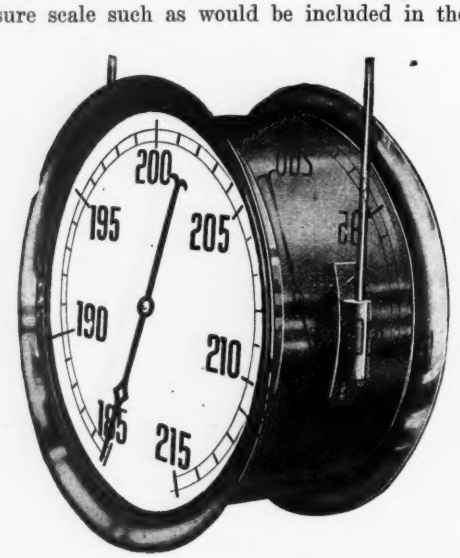
Let us send into our furnace and boiler rooms men who can show our engineers and firemen how to burn their fuel with the least waste.

Ashton Master Pilot Gages

TO MAINTAIN a boiler pressure within close limits, the fireman must have a gage with large unit divisions in order that small variations may readily be seen. This is one of the features of the Ashton Master Pilot gages with double illuminated dials which is particularly designed for use in large power plants containing a number of boilers. This gage is usually located in the center of the firing aisle where it may be seen from any part of the room and is suspended from overhead by rods attached to brackets on the sides of the gage.

Opal glass dials are used which are arranged so that electric lamps may be inserted inside the gage case from which the light is reflected through the dials, making it possible to see the indicating hands and the pressure marks at all times.

Graduations on the dials show only part of the pressure scale such as would be included in the ordinary range of pressure, which is usually 15 lb. above or below the working pressure. This permits the dials being graduated with large divisions between pressure marks and the use of large figures.



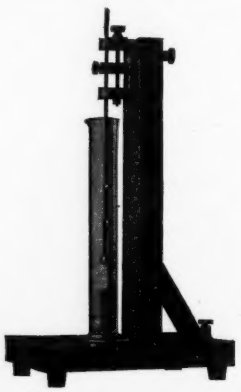
ASHTON MASTER PILOT GAGE WITH DOUBLE ILLUMINATED DIALS

These gages are manufactured by the Ashton Valve Co., of Boston, Mass.

Westinghouse Oil-Testing Cup

THE oil-testing cup shown in the accompanying illustration, and placed on the market by the Westinghouse Electric & Manufacturing Co. for convenience in making dielectric tests of insulating oil, consists of a graduated glass cylinder containing two testing terminals, each a brass sphere ½ in. in diameter. The upper sphere is adjustable in its distance from the lower one by hand or by means of a micrometer screw with a milled thread. All parts are readily accessible for cleaning, and the zero point of the gap may be quickly adjusted for each test.

To insure the most satisfactory performance of insulating oil, it should be kept free from dirt and moisture, and periodic tests should be made to determine its condition. The most dependable method of determining the value of insulating oil is to test its dielectric strength. This is best accomplished by immersing a spark gap in the oil, set at a known distance—generally 0.15 in.—and gradually raising the potential across the gap until rupture occurs. In making the test, a suitable quantity of oil is poured into the testing cup and the gap adjusted. The oil should then be allowed to stand for about 10 min. to allow air to escape. The testing voltage is then applied, low at the start but raised gradually without opening the circuit, until breakdown occurs. The oil should then be agitated and the test repeated, until 10 breakdowns have been obtained, the average of these being taken as the breakdown voltage of the oil.



WESTINGHOUSE OIL-TESTING CUP

The testing voltage should always be applied in the same manner. The gap may be fixed and an increasing voltage applied until breakdown occurs, or a constant voltage applied and the gap gradually shortened until rupture takes place.

Book Reviews

THEORY AND OPERATION OF DIRECT CURRENT MACHINERY, by C. M. Jansky; 285 pages, 214 illustrations; first edition; New York, 1917; price, $2.50.

As this text has been prepared primarily to meet the needs of students of limited mathematical training, it should find a ready reception by the so-called practical man desiring to improve his knowledge of direct-current compound machinery and its underlying principles of operation. Where simple mathematics has been introduced, the presentation of the subject matter is such as to enable the reader to neglect this portion of the text and still obtain a comprehensive understanding of the subject.

The opening chapters of the book are devoted exclusively to the subjects of magnetic principles, electromagnetism, electro-magnetic induction, units of measurement, and transformation of energy, thus giving the student a thorough grounding in the underlying principles before taking up the matter pertaining to the actual machine. Continuous current generators and motors and their magnetic circuits are treated in detail

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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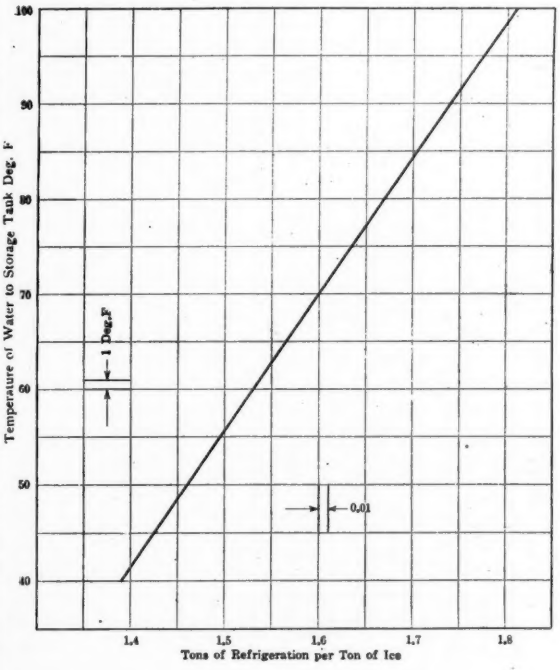
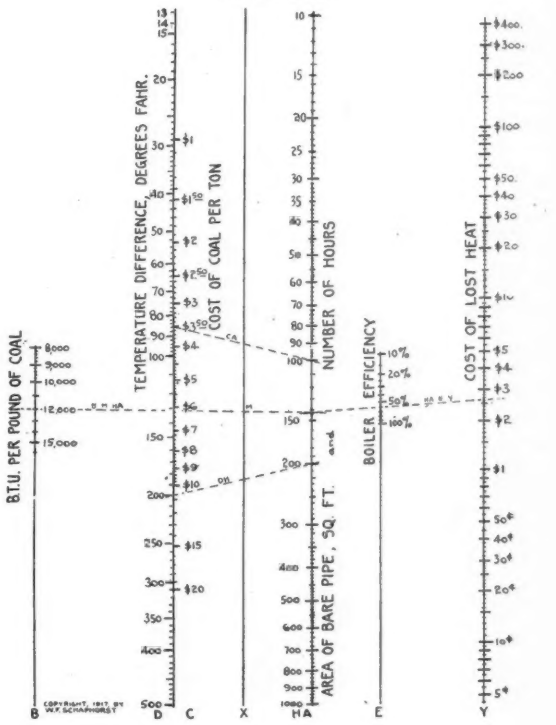
POWER PLANT ENGINEERING

RELATION OF STORAGE WATER TEMPERATURE TO TONS OF REFRIGERATION PER TON OF ICE



POWER PLANT ENGINEERING

CHART FOR DETERMINING COST OF HEAT LOSSES FROM BARE PIPES

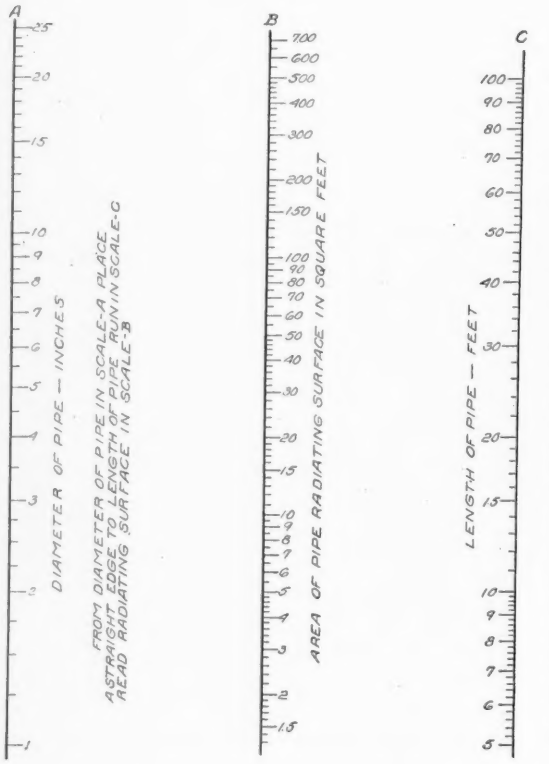


POWER PLANT ENGINEERING

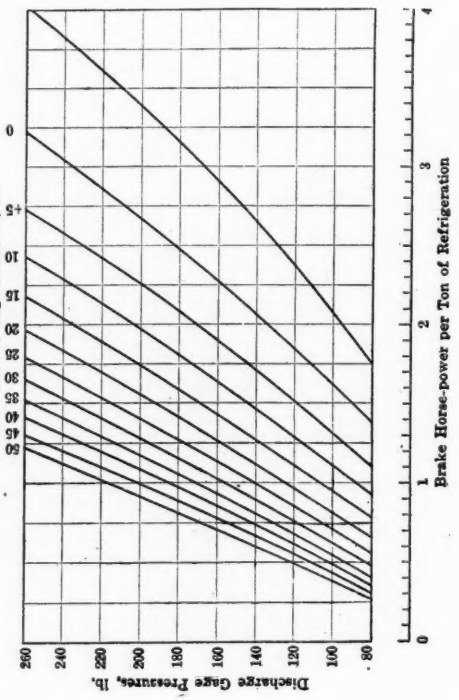
GALLONS OF CONDENSING WATER REQUIRED PER TON OF REFRIGERATION

Condenser Pressure, Lbs. Per Sq. Inch, Gage.	Corresponding Temp. Deg. F	60 Degrees F Water				70 Degrees F Water				80 Degrees F. Water				90 Degrees F. Water.			
		Range, Deg.F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb Gage.			Range, Deg. F	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb Gage.			Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage.			Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage		
			15	20	25		15	20	25		15	20	25		15	20	25
126.4	75	10	2 90	2 85	2.80												
131.4	77	12	2.40	2 35	2.30												
136.6	79	14	2.05	2 00	1.95												
141.8	81	16	1 85	1.80	1.75	6	4 87	4.80	4.70								
147.2	83	18	1.65	1 60	1 55	8	3.67	3.60	3.55								
152.7	85	20	1 47	1.45	1 41	10	2.95	2.90	2.85								
158.3	87	22	1 35	1 32	1 30	12	2 45	2.40	2.35								
164.1	89	24	1 25	1 22	1 20	14	2.10	2.05	2.00								
170 1	91	26	1 15	1 13	1 10	16	1 90	1 85	1.80	6	5.00	4.90	4.80				
176.2	93	28	1 08	1.05	1 03	18	1 68	1.63	1.60	8	3.75	3.70	3.65				
182.6	95	30	1.00	0.99	0 97	20	1.50	1 48	1.45	10	3.00	2.95	2.90				
189 1	97	32	0 95	0 93	0 90	22	1 38	1.35	1.32	12	2.52	2.48	2.43				
195 7	99					24	1.28	1.25	1.22	14	2.13	2.10	2.06				
202.5	101					26	1 17	1.15	1.13	16	1.92	1.85	1 83	6	5.10	5.00	4.90
209.5	103					28	1.10	1.07	1.05	18	1.70	1.67	1 63	8	3.83	3.75	3.70
216 5	105					30	1.02	1 00	0 98	20	1.53	1.50	1 48	10	3.07	3.00	2.95
223.7	107					32	0.95	0.93	0.92	22	1.40	1.37	1.35	12	2.57	2.51	2.47
231.1	109									24	1.30	1.28	1.25	14	2.19	2.13	2.10
238.7	111									26	1.20	1.16	1.15	16	1.95	1.90	1.88
246.5	113									28	1.12	1.08	1 06	18	1.74	1.69	1.65
254.5	115									30	1.05	1 02	1.00	20	1.56	1.53	1.40
262 7	117									32	1.00	0.98	0 95	22	1.43	1.40	1.37

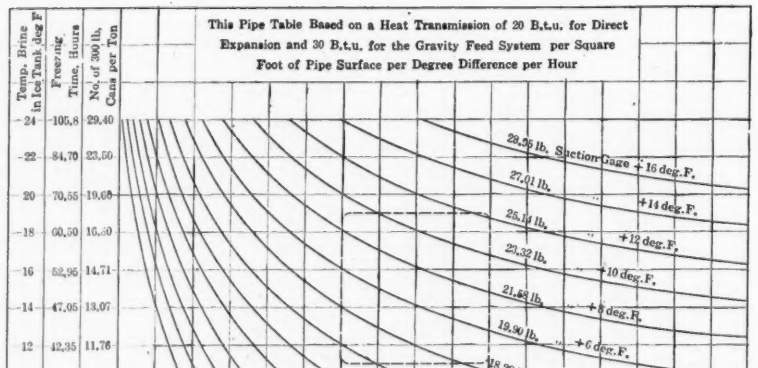
CHART FOR CALCULATING RADIATING SURFACE OF PIPE RUNS


A
B
C
DIAMETER OF PIPE — INCHES
AREA OF PIPE RADIATING SURFACE IN SQUARE FEET
LENGTH OF PIPE — FEET
FROM DIAMETER OF PIPE IN SCALE-A PLACE A STRAIGHT EDGE TO LENGTH OF PIPE RUN IN SCALE-C READ RADIATING SURFACE IN SCALE-B

RATIO OF SUCTION AND DISCHARGE PRESSURE TO HORSE-POWER REQUIRED PER TON OF REFRIGERATION



PIPE CHART FOR ICE PLANTS


This Pipe Table Based on a Heat Transmission of 20 B.t.u. for Direct Expansion and 30 B.t.u. for the Gravity Feed System per Square Foot of Pipe Surface per Degree Difference per Hour
Temp. Brine in Ice Tank, deg F
Freezing Time, Hours
No. of 300 lb. Cans per Ton
Lineal Feet of 1¼ In. Extra Heavy Pipe per Ton of Ice - for Gravity Feed System

For 40 deg. water temperature multiply values by 0.868
50 " " " " 0.912
60 " " " " 0.956
80 " " " " 1.044
90 " " " " 1.089

in Chapters VI and VII; while armatures, uses of electric energy, types of dynamos and commutation are discussed in Chapters VIII to XI, inclusive. The five remaining chapters are devoted entirely to the operation of direct-current machinery.

As an aid to the student, a recapitulation of the most important facts has been introduced at the end of each chapter.

THE SAFETY of the home is the subject of Circular No. 75, just issued by the Bureau of Standards, Department of Commerce. An interesting account of household hazards is given. The topics are discussed clearly in a manner which would afford a basis for popular education in "Safety First." The dangers from electricity, gas, fire, lightning, household chemicals, and the other common causes of accident are recited and many actual cases are described. The purpose is to aid in removing needless risk and fear, and to develop intelligent caution where the hazard cannot be entirely avoided.

The hazards of the home have increased in modern times from the service of gas and electricity and the use of such dangerous articles as matches, volatile oils, poisons, and the like. The use of energy in the home necessarily involves some risk which intelligent planning and care will reduce to a minimum.

Caution alone is not enough, since many of the dangers are not even suspected. The nature of such unknown hazards must be made plain. The circular emphasizes the seriousness of some of the risks not generally known, gives simple cautions, and aims to guide the formation of habits of carefulness. The circular also suggests effective home equipment to minimize the risks involved, and aims to encourage public measures to provide safety for the household and community.

It is intended, not to increase fear of accident, but rather to remove the causes and the need for alarm. The sense of safety to be gained by observing these cautions would alone justify the careful study of this new circular. This circular completes the series of three popular household circulars which deal with measurements, materials and safety. These form a valuable addition by the Bureau of Standards to the literature on household management.

The appalling loss of life from avoidable causes and injury to person and property make the pamphlet especially timely. It is believed that thousands of human lives could be saved and accidents reduced to the minimum if the precautions suggested are followed. Copies of this circular can be purchased at a nominal cost of 15 cents per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C.

THE UNIVERSITY OF TENNESSEE is rendering a distinct service in the publication of two pamphlets, one addressed to the householder on Economical Firing of Tennessee coals for House Heating, the other to the Power Plant Manager on Economical Firing of Tennessee Coals under Power Plant Boilers.

Each explains, in simple language, the proper conditions to be maintained for efficient combustion, proper air supply, prevention of air leaks, regular attention to firing and the fire bed, keeping surfaces clean, and reducing after loss in leakage of steam, and overheating of rooms. These directions, if carefully followed, will aid, not only in conserving of our coal supply, but in reducing the fuel bills of the householder and plant owner. They can be had from the University of Tennessee Press, Knoxville, Tenn.

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS; Philadelphia, 1918; 9 by 7 inches; 276 pages; 213 illustrations; cloth; $1.00.

Saving of coal is the purpose of this practical handbook, which is addressed to power plant owners, managers, engineers, and firemen. The preface states that such statements, tables, charts, etc., have been selected as were supported by experiments and tests, references being given wherever possible to the original authorities.

The work is divided into five sections, the first of which is about "Fuels," under which are considered the coals of the United States and their classifications, coal sampling, proximate analysis, ultimate analysis, heating value of coal, purchase of coal under specification, washing of coal, oil fuels, and gaseous fuels.

The second section is on "Combustion," taking up the chemistry of combustion, air theoretically required, grates and grate surface, hand firing methods, thickness of fire, mechanical stokers, and their operation, burning oil fuel, burning gaseous fuels, and burning powdered coal.

The third section treats of "Heat Absorption," including heat transmission by conduction, convection and radiation, soot, scale, softening feed water, and feed water heating.

The fourth section on "Boiler Efficiency and Boiler Testing," covers heat balance, heat absorbed by boiler, heat losses due to moisture in the coal, hydrogen, chimney gases, CO, combustible in the ash, moisture in the air, and unaccounted for loss.

The fifth section on "Boiler Plant Proportioning and Management," discusses various arrangements of auxiliaries with regard to their effect upon feed heating, and also describes the Polakov functional system of boiler room management.

The book has been compiled by George H. Gibson, member American Society of Mechanical Engineers, assisted by Percy S. Lyon, now captain of Coast Artillery. The proofs were read by Henry Kreisinger, who conducted for the U. S. Bureau of Mines many of the investigations quoted in the text.

Catalog Notes

DESCRIBING the Moloch type "H" stoker, the Moloch Stoker Co., of Chicago, has published a very attractive and instructive catalog showing full illustrations of the construction and operation of the stoker, its installation under different types of boilers, and many plants where it is now in use. Not only are clear halftones shown of all details, but also blueprints giving the installation arrangement and layout of piping, for single stokers and for furnaces carrying two and three stokers in a single furnace.

TECHNICAL INFORMATION regarding Bakelite Micarta-D Gears is contained in a pamphlet recently published by the Westinghouse Electric & Manufactur-

ing Co. The distinctive features of this material for noiseless gears and pinions are listed, together with its physical properties. Methods of turning and drilling, and gear cutting are described and illustrated with many halftones and drawings. Methods of attaching to the driving shaft which have proved suitable for gears of all sizes are shown and tables of pitch, teeth and other gear data are also given. There are formulas for the horsepower rating, the amount of power which can be transmitted through press fit and for calculating other variables in gear practice. The book, which is of 12 pages, is a valuable addition to the library of anyone who has to do with noiseless gears. It will be sent on request to the company's nearest office.

THE BUREAU OF MINES, Department of Interior, Washington, has prepared a poster on resuscitation after gas asphyxiation, drowning or electric shock. This is intended for posting in establishments where accidents of this kind are likely to happen, and gives brief but full directions for treatment in each case, and for the method of applying the prone position system for artificial respiration. Copies may be had on request from the bureau as long as the edition lasts.

GRAPHITE FOR THE BOILER is a booklet published by The Joseph Dixon Crucible Co., Jersey City, N. J., that tells in a clear and concise manner why Dixon's Pioneer Boiler Graphite is a most satisfactory remedy for boiler scale. It deals with the reason why boiler graphite should be used, the method by which it is applied and the results that are being obtained. Write for Booklet No. 155-T.

YARNALL-WARING CO., Chestnut Hill, Philadelphia, has just issued bulletins illustrating and describing the company's Simplex Seatless blowoff valve and Simplex pipe-joint clamp, also a pamphlet listing some of the users of Simplex blowoff valves, together with some sample reports and photographs of installations. The company will gladly send copies of these publications to anyone interested.

RATEAU STEAM REGENERATOR CO., 90 West St., New York, has recently issued a catalog describing the operation of the Rateau steam regenerator interposed between mill and hoisting engines and low-pressure steam turbines. Illustrations include sections, charts, and steam consumption diagrams.

TUXEDO SWING JOINTS and unions for steam, gas, oil, air, and water are described in a new booklet which also illustrates them as applied to presses and boiler feeders, and gives price lists. These joints and unions are made by Franklin Williams, Inc., 39 Cortlandt St., New York.

SUCTION CONVEYING APPARATUS manufactured by The Vacuum Ash & Soot Conveyor Co., 2 Rector St., New York, is illustrated and its principal features are discussed in a pamphlet lately received.

HOUGHTON'S CYL-TAL, a concentrated lubricant for steam engine cylinders is the subject of Form 8339, recently received from E. F. Houghton & Co., of Philadelphia.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

(Established over 22 years.)

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

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All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

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Technical Publishing Company

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer experienced with producer gas and oil engines, a.c. and d.c. equipment, pumps, storage batteries, interior wiring and repair work. Technical graduate. References. Address Box 501, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-1-1

POSITION WANTED—By young man as oiler in large central station, with 7 years' experience with Corliss engines up to 400 hp., d.c. generator. I. C. S. graduate on complete Steam Engineering. Age 27. Married. Best of reference. Will go any place. Address Box 493, Power Plant Engineering, 537 S. Dearborn St., Chicago. Ill. 1-15-1

POSITION WANTED—As helper or oiler in small or large plant. Will come at once. Sober and industrious. Will consider reasonable salary. Address Box 494, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-15-1

POSITION WANTED—By young man as oiler or assistant engineer in or around Chicago, with chance of advancement. Eight years' experience; ready to start work at a week's notice; references. Address Box 492, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-15-1

POSITION WANTED—Chief engineer desires change of location. Competent to handle large plant. Experienced with a.c. and d.c. machinery, irrigating machinery, ammonia compressors (practical ice-making), gas engines and air compressors. Can install and do repairs. Not liable to conscription. Address Box 495, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-2

POSITION WANTED—By experienced fireman and engineer who has had charge of waterworks plant, and effected saving of half the coal bill by overhauling the plant. Familiar with electrical work. Address Box 507, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1.

POSITION WANTED—By middle aged man and chief engineer's license. Can handle D. C. & A. C. machinery, steam boilers, gas and oil engines. Also experienced in wiring and repair work. Address Box 508, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

POSITION WANTED—By an engineer with 13 years' experience with boilers, engines, electrical and refrigerating machinery. Wishes to connect with a permanent, reliable concern. Am familiar with flue gas analyzing instruments and furnace efficiency methods. Address Box 509, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities; Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

BOILER HOUSE MECHANIC WANTED—A good mechanic, to act as general boiler room repair man in large mill out of town. Must be familiar with machinery, boilers, stokers, etc. State age, married or single, experience and enclose copy of references. Address Box 510, Power Plant Engineering, 537 S. Dearborn St., Chicago. 2-15-3

WANTED—Man to do general repair work in central station. Must be able to do lathe work, repair boilers, etc. Consolidated St. & Power Co., Kewanee, Ill. 2-15-1

WANTED—Superintendent for Gas Plant—2 benches silica sixes. Must have had 3 yrs. actual experience. Reference required. Good salary. Address Consumers Gas & Coke Co., Waycross, Ga. tf.

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—2 Stationary Engineers with Ohio State License to fire and operate 250 HP. power plant in town of 30,000; salary $110 per month. Also 2 men with Ohio License to operate plant in town of 1200—$105 night engineer, $110 day engineer—no firing. Applicants state present employment and experience. Address Box 506, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-1-1

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

WANTED—Agents to call upon engineers to sell positively the best pump valve on the market. Excellent proposition. Big money maker. Address Box 500, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Agents handling engine and boiler room specialties in every section for our Boiler Girth Seam Protector. Liberal inducements. Give experience and territory covered. Address National Boiler Protector Co., Dayton, Ohio. tf.

WANTED—Desire to purchase a complete set of 1916 copies of Power Plant Engineering (formerly Practical Engineer). State price. Address Bix 504, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-15-3

WANTED to represent at St. Louis, manufacturer selling to mining, machine shop or power plant trade. Office established, long business experience, adequate endorsement furnished. Write 413 Bank of Commerce Bldg., St. Louis. 2-1-1

WANTED—Exclusive agency for machinery or supplies salable to mining, machine shop or power plant trade. Have a well established office; best of references. Only substantial business desired. Write 413 Bank of Commerce Bldg., St. Louis. 2-1-1

For Sale

FOR SALE—60-hp. horizontal boiler, 28-hp. Russell steam engine, Peerless generator, 125 volts, 15-kw. All in good condition. J. D. Hamlin, Marshallville, O. 2-15-1

FOR SALE—250-volt D. C. units.

Kw.	Generator	Engine	Price
75	G. E. 3-wire	Harrisburg	$1800
50	G. E. 3-wire	Harrisburg	1500
37½	Wghse. 3-wire	Skinner	1100

Power Machinery Exchange, Inc., Jersey City, N. J. tf.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St. N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS—Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf.

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

Seedtime in the Power Plant

Back yard farmers added $340,000,000 in 1917 to the food resources of the nation.

This year the home garden will prove a still more potent factor in feeding America and her allies.

We need the back yard commissary even more in 1918; food is scarcer and higher; there is more incentive to plant and cultivate; failures will be fewer; yields greater, because we know how to get results.

People who could not tell a beet from a turnip a year ago, now talk glibly of varieties, of soil conditions, of fertilizers. They know what to plant—when, where, and how to plant it.

How have multitudes so quickly learned the joy and wonder of growth? How have they so easily acquired the secrets of Mother Nature?

Experience has played a part. But most important in this education have been the garden guide, the seedsman's annual, the pamphlets and bulletins of the U. S. Department of Agriculture.

A wonderful force—this garden movement; its seed a world need; its root struck deep in a nation's resolve; its fruit a trained army of producers!

Wonderful indeed! Yet far more wonderful the printed word that made this reality possible. Far more wonderful the printer's ink that transformed America into a nation of successful gardeners overnight.

All over our broad land at this moment, those who have or can get a bit of land to till, are fingering the seed catalogs, draughting garden plans, making up orders. For planting time is at hand.

Even the youngest and least expert plans with assurance. No one doubts the success of his 1918 garden. He is posted—has fortified himself against failure. To his own stock of experience he has added the experience of others.

He has studied his catalog. He knows if he follows this guide, he cannot go wrong. Wilful neglect, carelessness, some unforeseen stress of season or uncontrollable circumstances may destroy his crop.

But barring these, his crop is sure because he selected **tested varieties,** pedigreed strains.

You, too, like the home gardener, should now be casting a forward eye to the 1918 harvest.

If you would insure a profitable yield, sow early. Make up your list of 1918 equipment needs now with the help of an illustrated directory where only **tested** products are listed.

Such a directory is POWER PLANT ENGINEERING. Its advertising pages include practically every machine or material required to run your plant.